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AN INTERNATIONAL REVIEW OF FORESTRY AND FOREST PRODUCTS

The Story of FAO

Gove Hambidge. pp. 303. D. van Nostrand Company Inc., 250 Fourth Avenue. New York 3: D. van Nostrand Company (Canada), Ltd., 25 Hollinger Road, Toronto. U.S. $6.50.

(*All royalties from the publication of this book are paid to FAO*).

MR. Gove Hambidge, North American Regional Representative of the Director-General of FAO, has traced in this book the background, genesis and development of FAO — "an interesting, satisfying, and hope-inspiring presentation of a truly great international co-operative endeavor to promote peace and welfare in a troubled world."

The Director-General writes in a foreword — "All too often I have been asked why more people do not know about FAO, why so many thousands who share a belief in its objectives have no understanding of its activities, or are unaware of its existence.

... it is no simple task to tell the world about the job of FAO, especially when its limited resources are of necessity largely consumed in doing that job. Yet it is of the utmost importance that the world know FAO — what it is, what it does, and how it does it.

... we are keenly aware of the impediments we face, the barriers we have to surmount, the disappointments we must encounter every day, and the failures we have at times been forced to acknowledge. But in spite of all this, we try always to see the horizon toward which we struggle, and we have a heartening feeling that we are making steady progress, as I believe this book shows."

Fishing Boats of the World

Edited by FAO. 650 pp. 600 illus. The Fishing News, Arthur J. Heighway Publications Ltd., Ludgate House, 110 Fleet Street, London E.C. 4. 1955. £4.10s. or U.S. $12.50.

THIS publication contains the technical papers and records of the discussions of the FAO International Fishing Boat Congress held in Paris (France) and Miami (U.S.A.) in 1953, to which 140 naval architects, boat builders, marine engineers and other experts from 23 countries contributed.

In its two sections the book deals with a wide range of subjects, Part I dealing with boat types, short distance fishing, bottom fishing, combination fishing, research vessels, materials, fish-holds and economics, while Part II is concerned with naval architecture and with special reference to experience gained in notable freezer-trawlers.

As may be expected, the contributions of experts from so many countries on the subject of boat design, hull shapes and the qualities and defects of different boats raise some interesting and controversial points. There is frequent reference to the replacement of timber in boat building by steel, alloys or plastics, and it is suggested that timber is not being used to the best advantage. Information is given on the preservation of wooden vessels, the problem of obtaining the best types of timber, and the designs which make the best use of its properties.

In the engineering section there is a lively discussion on the different types of engine and many interesting points of view are put forward.

The importance of this book lies not only in its value as a work of reference for all engaged in the fishing-boat building industry, but in the fact that it is concerned with that part of fishing boat design which is frequently absent from textbooks on naval architecture; that is, views and ideas based on the extensive practical experience of marine engineers and many other experts from all over the world.

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An International Review of Forestry and Forest Products

Vol. 9, No. 2 **June, 1955**

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FANTASY OR FACT

So much publicity is given at present to the terrifying and destructive aspects of atomic energy that the important work being done on its possible application to peaceful uses is too easily overshadowed.

The great range of these possibilities will be discussed at a special international conference organized by the United Nations in Geneva next August. FAO will be participating in this investigation of the possibilities for applying these new forces in the struggle against world-wide problems of hunger, poverty and disease.

Until atomic power can be produced on a large scale for industrial purposes, the immediate importance of atomic energy to forestry will be in the field of research, in the use of radioactive materials for testing and processing forest products, and in tree and range plant breeding. In research, the so-called tracer studies have already given impressive results in elucidating many nutritional processes in plants that have hitherto required considerable expenditures of time and money. There is also already ample evidence that the use of new kinds of radiation in plant breeding can produce plants with new or greatly modified characteristics, such as greater disease-resistance or more efficient growth habits. The result could be a much wider range of improved types for the forester.

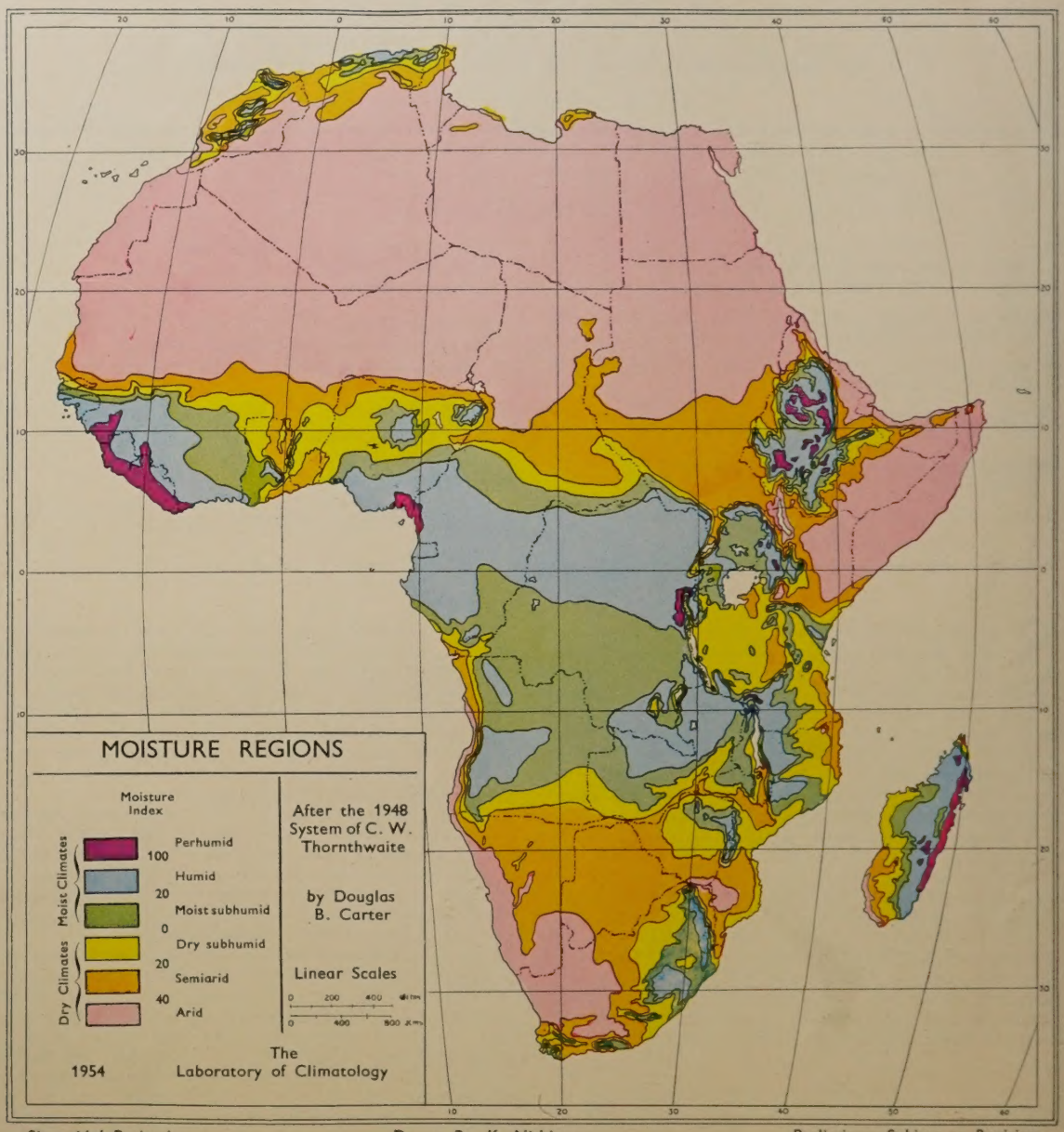
Unfortunately, the day when cheap atomic power will be available on a large scale for industry in those countries lacking traditional fuels for energy production is still far off. Its eventual use as a source of power may, however, be of outstanding importance, not least to industries based on forest products.

The world-wide expansion in the use of atomic energy that will undoubtedly take place in the coming years makes it essential that the effects of radiation on plant growth and reproduction, the movement of radioactive products in the soil, their uptake and concentration by plants and their immediate and long-term effects on men and animals should be thoroughly understood.

Many countries are already conducting their own investigations into these specialized problems and it is highly desirable that the technical information relating to the various fields of agriculture should be widely disseminated and authoritatively interpreted. FAO is in a unique position to do this, in a way that can foster public confidence in the constructive uses of the power of the atom.

The exact nature of the Organization's activities in this field will be decided by the full Conference of FAO when it assembles at Rome in November of this year. The Conference will also at that time be examining a proposal of the Director-General to initiate a survey and appraisal of world agricultural, fishery and forest resources in relation to needs. More reliable knowledge of the relative production potentialities of the physical and biological resources in various parts of the world would be of the greatest value as a guide to longer-term programming. This is especially true for the technical assistance program where broader perspectives, going beyond national boundaries, are needed for the appraisal of alternative lines of work.

Cover photograph: Japan. *Girls transplanting seedlings in a forest nursery. Artificial regeneration of forests by planting is much relied on in Japan. A common management method is to clear cut areas of a standard size of four hectares and immediately to restock with coniferous species. Delegates to the recent third session of the FAO Asia-Pacific Forestry Commission saw such areas in the Kiso National Forest, planted chiefly with* Chamaecyparis obtusa.



Sinusoidal Projection Drawn By K. Nishimoto Preliminary-Subject to Revision

This map expresses the sum total of the data on average potential evapotranspiration, water deficiency and water surplus in Africa, as depicted on other maps in this series which have not been reproduced here.

Climatic Classification in Forestry

by C. W. Thornthwaite and F. Kenneth Hare[1]

Climates, like nearly all other variable quantities, can be classified. But it is important to realize that the taxonomy of climate is not the same as that which arranges living organisms into species, genera and so to the phylum. However much the biologists may disagree as to what constitutes a species, there is no doubt that the living world is divisible into groups that are, on the whole, mutually distinct; between the genera *Abies* and *Picea* there are differences of morphology, of physiology and of genetic characteristics that are too strong to be lightly disregarded. But no such striking differences need separate adjacent climates. On the contrary, one climate tends to grade into another by continuous transition. Only rarely do we find climatic boundaries that approach in sharpness the difference, for example, between *Pinus* and *Taxus*.

Clearly, the real analogy is between climatic classification and the classification of soils or natural vegetation; it is commonplace that the grasslands of the world normally grade into forest through a broad ecotone of park or savannah. It is difficult to classify *rationally* such a natural complex as soil or vegetation; yet such classification is necessary, and it is groping toward reality. There is no doubt that "coniferous forest" is a real entity, however difficult it may be to define its limits. It is likewise with climate. In the face of complex geographical variation of climate, it is necessary to recognize climatic types and their geographical equivalent, climatic regions. The purpose of a climatic classification is to provide a concise description of the various climatic types in terms of the truly active factors of climate, primarily those of moisture and heat. The value of any classification depends, first, on the accuracy with which the climatic regions are identified and their boundaries located, and second, on the skill with which numerical parameters are selected to define these boundaries, *as well as to specify conditions lying within them.*

The forester and the silviculturist have a legitimate interest in this subject. For many years it has been customary to regard natural vegetation and soil as complex functions of climate, whether on the continental scale (as in Clements' climax formations) or on the purely local scale where the concept of *site* is applicable. That forest vegetation is distributed in response to certain external climatic controls and that forests are themselves major conditioners of microclimates and even macroclimates are by now well-known facts. But to the Food and Agriculture Organization, the question of climatic classification assumes an altogether more practical significance, because of its interest in tree-planting, especially of exotic species. The Asia-Pacific Forestry Commission, at its second session in Singapore, December 1-13, 1952, asked the World Meteorological Organization (WMO), through the Director of the Forestry Division of FAO, to recommend a standard scheme of climatic classification...

> "... based on the relationships between climate and vegetation... Such a classification would be extremely useful to forestry agencies of our Member Governments as a guide for the choice of exotic species for trial plantings."[2]

In 1954, the Eighth General Conference of UNESCO in Montevideo discussed a plan of procedure for research in the humid tropics. The Proposed Programme and Budget for 1955 and 1956 included the following recommendation:

> "Maps delimiting the humid tropical areas and showing those areas which experience similar climatic conditions are considered to be a prerequisite for the work of the programme."[3]

This interest by different agencies within the United Nations Organization is but the reflection of a growing awareness in all countries of the need for accurate and detailed climatic information.

The present authors doubt whether any classification yet exists that deserves to be adopted as "standard." It may be a long time before anything approaching a standard can be achieved. But a review of existing methods may be useful: that is what is attempted in this article.

Brief historical review

The earliest attempts at climatic classification in the modern sense were made in the mid-nineteenth century, chiefly by natural historians and biologists. From the very beginning the initiative in such classification has rested with the biologists, and it has been from these students of the living cover of the earth that most of the actual systems of classification have come. Both of the present authors have published reviews of this early phase with abundant literature citations, and

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[1] C. W. Thornthwaite is Director of the Laboratory of Climatology, Centerton, N. J., U.S.A., and President, WMO Commission for Climatology: F. Kenneth Hare is Chairman of the Department of Geography, McGill University, Montreal, Quebec, Canada.

[2] Quoted in Annex II to Recommendation 8, Abridged Final Report of the First Session, Commission for Climatology, World Meteorological Organization, Washington, March 12-25, 1953, pp. 40-41.

[3] Quoted from Proposed Programme and Budget for 1955 and 1956, UNESCO, 8th General Conference, Montevideo, 1954, paragraph 86.

only the briefest treatment is needed here.[4] In 1866, A. Grisebach published the earliest significant world map of vegetation regions. Coming as it did shortly after the great plant physiologist, Alphonse de Candolle, had published his massive investigations into the factors influencing the distribution of plant species, Grisebach's attempt at the classification of world vegetation was a challenge to students of climate to look for correspondences between temperature or precipitation data and the world distribution of vegetation. At the same time, among biologists there was extensive investigation of the effect of climate on the phenology, growth and development of plant species. The monographs of Carl Linsser are the outstanding monument to this phase; his work, concerned with the effects of temperature on phenology and rainfall on vegetation, led him to divide the world into climatic zones, thereby making himself the first to attempt a true classification of climates on the basis of vegetation zones. Later, de Candolle published a physiological classification of plants based on adaptation to climate in which the familiar terms "megathermal", "xerophilous", "mesothermal" and "microthermal" appeared for the first time.

TABLE 1. — CLIMATIC ZONES OF THE WORLD

Climates	Symbol	Köppen's name	Equivalent de Candolle zone	Climatic limits
Tree[1]	A	Tropical rainy	Mega-thermal	Coldest month temperature above 18°C. (64°F.)
	C	Warm temperate	Meso-thermal	Coldest month between –3°C (27°F) and 18°C (64°F.).
	D	Boreal	Microther-mal	Coldest month below –3°C. (27°F) warmest above 10°C (50°F.)
Snow[2]	E	Snow	Hekisto-thermal	Warmest month below 10°C. (50°F.)
Dry[3]	B	Dry	Xerophilous	Annual rainfall less than R.[4]

[1] With enough rainfall for forest vegetation.
[2] Too cool for tree growth.
[3] Too dry for tree growth.
[4] For derivation, see following text.

Thus by 1875 the idea that climates might be classified according to the type of vegetation or physiological response they produced was well established. But it was left to a St. Petersburg trained biologist, Wladimir Köppen, to take this idea and elevate it into a primacy of place that it has never lost. Köppen's interest carried him into climatology, which he dominated for some 60 years, and his climatic classification continues in use even today among geographers. His first work on heat and plant growth was in the tradition of Linsser and de Candolle, but he soon turned to the task of defining world climatic regions objectively. His early training, and his familiarity with the works of Oscar Drude and Grisebach, led him to the idea that plants might serve as instruments integrating the various climatic elements, and that their distribution might therefore be assumed to identify climatic regions. This idea subsequently dominated his life's work and the thinking of a whole generation of climatologists.

Köppen first presented his classification in 1900, and thereafter modified it frequently and extensively until his last paper appeared in 1936. He took de Candolle's plant regions or vegetation zones and endeavored to find climatic correspondences for their boundaries, a search that continued the rest of his days. His primary division of the earth's surface was into five great zones, following de Candolle, separated by certain critical values of temperature and precipitation. To use Köppen's own terms, these five zones comprise a "dry climate", a "snow climate", and three "tree climates", arranged as in Table 1.

Thus Köppen's limits are essentially simple averages of the directly observed values of the climatic elements. The "dry" climates (B) are those whose annual rainfall is less than a value that depends on the mean annual temperature. Köppen used many different formulae to determine this critical rainfall (R). In 1928 he adopted (as a final form) the value:

$$R = 0.44\ (T - k),$$

where T = mean annual temperature, and
k = a constant whose value is determined by the seasonal concentration of rainfall.

Stations having rainfall greater than R thus fall into the humid group, which includes both tree and snow climates. Simple values of mean temperature for the coldest or warmest month separate them into A, C, D, and E groups. The primary climates are further subdivided according to the seasonal distribution of rainfall and temperature, again using averages of the simple measures of these quantities.

In spite of the wide currency it achieved, the Köppen system was always unsatisfactory, and is quite futile as a method for classifying forest climates. In the first place, it is a crude, blunt instrument; the regions it defines are large and unwieldy, and do *not* correspond to major divisions of the vegetation of the earth. Nor is there any point in trying to adjust the regional boundaries by shifting their numerical value as has often been done. Köppen's use of simple temperature and precipitation values to define boundaries entirely misses the point, as do all the schemes produced by his imitators and apologists. The fact that a particular isopleth of mean air temperature happens to follow a soil or vegetation boundary is to a large extent fortuitous. Any effective system must endeavor to answer the questions, "What are the real, active processes of climatic control? And how can suitable parameters for these processes be devised?"

[4] THORNTHWAITE, C. W., Problems in the classification of climates, *The Geographical Review*, vol. 33, no. 2, 1943, pp. 233-255.

HARE, F. K., Climatic classification, *The London Essays in Geography*, ed. L. D. Stamp and S. W. Wooldridge, Harvard University Press, Cambridge, 1951, pp. 111-134.

Climatic processes

The climate of a locality, considered statistically, is often regarded simply as "average weather", which is essentially a meteorologist's view. Climate considered in the light of physical processes is better thought of as the complex interaction of vegetation and atmosphere at the earth's surface, especially as expressed in the exchanges of energy, moisture and momentum between the surface and the atmosphere. We believe that a soundly based classification, of real value in the study of vegetation, ought to seek its parameters in these complex exchanges, and not in the raw observational data of the meteorologist.

In the new classification of climate which Thornthwaite proposed in 1948, he gave great prominence to natural evaporation, or *evapotranspiration*, to give it the term it merits over a vegetation-covered continent. The principal parameter of Thornthwaite's classification is a climatic potential derived from the thermal regime, the *potential evapotranspiration*. To justify the cardinal role applied to these quantities, it will be necessary at this stage to digress upon the nature of evaporation over a land surface, since great confusion exists in the literature of the ecologist and plant physiologist on this point.

Evaporation — the change in state of water from liquid to vapor — represents an important mass transfer from ground to atmosphere, the reverse of precipitation in the hydrologic cycle. But it is also an important agency of energy transfer, since vast amounts of heat are required to bring the evaporation about, and are then transferred to the air with the vapor as latent heat. Thus natural evaporation is much more than the reverse of rainfall; it is also a reverse flow to the downward stream of radiation from sun and atmosphere that warms the soil surface. A single parameter, measured evaporation or computed potential, hence at one time demonstrates two of the principal exchanges between earth and atmosphere.

Natural evaporation from the land whether evaporation from ponds, lakes and rivers, intercepted rainfall from the leaves and stems of plants, direct evaporation from the soil surface, or transpiration from green plant tissues, can proceed only when the vapor pressure of the ambient air is less than the vapor pressure at the evaporating surface, and can continue only while there is an external source of energy. The measurement of evaporation presents many difficulties. Instruments like the porous bulb atmometer and the evaporation pan are of little value in estimating evapotranspiration. They measure, rather arbitrarily, some function of the evaporating power of the air at the level of exposure. But no close relationship exists between this function and the actual upward flow of vapor from the nearby land-surface. To measure natural evaporation, the instrument must simulate closely the natural conditions of surface, exposure, *albedo*[5] and water-supply, or else it must be designed to measure the actual flow of moisture from the ground to the atmosphere, as an electric meter measures consumed electricity.[6] Actually, there are only two practicable ways of instrumentally measuring evaporation under natural conditions: the "vapor transport" method using measured values of wind speed and humidity at two levels and the method utilizing soil filled tanks or evapotranspirometers. The vapor transport method is still not entirely practical due to observational limitations but evapotranspirometers have been installed in many parts of the world, and observations are now available for a number of years.[7] The problem of devising an evapotranspirometer below a tree-covered surface remains unsolved. It may be noted in passing, however, that stream discharge from watersheds with known rainfalls gives an indirect measure of evapotranspiration, though there is a long lag between the accumulation of surplus rainfall and its discharge from the watershed.

From this increasing inventory of evaporation measurements, certain conclusions are permissible. Evapotranspiration clearly depends on the:

(*a*) external supply of energy to the evaporating surface, principally by solar radiation;

(*b*) capacity of the air to remove the vapor, i.e., on wind speed, turbulent structure and the decrease of vapor concentration with height;

(*c*) nature of the vegetation, especially as regards its capacity to reflect incident radiation, the extent to which it fully occupies the soil, and the depth of its root system;

(*d*) nature of the soil, especially the amount of available water in the root zone.

Of these four, the meteorological controls (*a*) and (*b*) rank larger than the biotic and edaphic controls (*c*) and (*d*), a claim that will surprise many foresters. Actually (*a*) and (*b*) are closely related, since to a large extent the turbulent structure of the lower atmosphere depends on the same radiative and mass exchange processes that contribute the energy needed for evaporation. Similarly (*c*) and (*d*) are closely related.

There is no doubt that (*a*) is the master item in this list. Natural evaporation requires the latent heat of vaporization, and in practice this comes mainly from incoming solar radiation. Some of the radiation is reflected back from the surface, the percentage lost being known as the *albedo*. Some is used to heat the soil. Some goes to create convection within the air. The rest is used for evapotranspiration.

Different types of vegetation differ in their potential evapotranspiration because they absorb different amounts of solar radiation. Ångström has given the albedos of a few different surfaces as follows: grass 0.26; oak woodland, 0.175; and pine forest, 0.14.[8] Thus the pine forest might absorb 16 percent more energy than the grassland but the proportion available for evapotranspiration varies through a narrower percentage range. Most common garden vegetables and field crops absorb about the same amount of solar energy as grassland. Some types of forest may have a higher albedo than

[5] For an explanation of this term see following text.

[6] Thornthwaite, C. W., and Holzman, Benjamin., Measurement of evaporation from land and water surfaces, *U.S. Dept. Agric. Tech. Bul.* No. 817, 1942, 143 pp. — Thornthwaite, C.W., with Wilm, H. G. and others. Report of the committee on evaporation and transpiration, *Trans. Amer. Geophys. Union*, vol. 27, no. 5, 1946, pp. 721-723.

[7] Mather, J. R. The measurement of potential evapotranspiration, *Publications in Climatology*, The Johns Hopkins University Laboratory of Climatology, Seabrook, New Jersey, vol. VII, no. 1, 1954, 224 pp.

[8] Ångström, A. The albedo of various surfaces of ground, *Geografiska Annaler*, H. 4, 1925, pp. 323-342.

grass although we have no records of them; if such exist they would transpire less than grassland.

A grassland may easily consume 80 percent of the incoming net radiation for evapotranspiration when the soil is moist, and mature high forest cannot transpire much more. Table 2 shows how the available energy was partitioned during an experimental period in August 1953, over the Nebraska prairies.[9]

TABLE 2. — ENERGY USED FOR CONVECTION, EVAPOTRANSPIRATION, AND STORAGE IN THE SOIL, TOGETHER WITH WATER-CONTENT OF SOIL, OVER GRASSLAND, O'NEILL, NEBRASKA, U.S.A.

Date	Heat Used for Convection (C)	Heat Stored in Soil (S)	Heat Used for Evapo-transpiration (E)	Total (C+S+E)	$\frac{E}{C+S+E}$	Available Soil Moisture in Top 45 cm. of Soil
	(cal/cm²)	(cal/cm²)	(cal/cm²)	(cal/cm²)	(%)	(cm.)
Aug. 13-14	56.3	29.7	377.2	463.2	81	4.2
Aug. 18-19	59.1	–4.8	287.8	342.1	84	3.6
Aug. 22	98.4	19.0	216.2	333.6	65	3.0
Aug. 25	181.9	41.5	131.8	355.2	37	2.7
Aug. 31	242.3	28.3	44.5	315.1	14	1.9

When the soil of this grassland was moist, over 80 percent of the available energy was utilized for evapotranspiration, whereas only 14 percent was consumed two weeks later when the soil had partially dried out. In other words, over moist soils, a grassland is an extremely efficient evaporator. Forest vegetation can do little better; for, even if all the energy is used for evapotranspiration, the total flow can only be 25 percent greater. Those forms of forest having a lower albedo than grassland will hence absorb more energy, and will have more available for evapotranspiration. But the difference is small.

The idea that forest vegetation, under moist conditions, differs little from grassland in the power to evapotranspire will strike an unfamiliar note to many readers. The literature is full of accounts of exceedingly high transpiration rates from isolated trees, set in pasture or on river banks; and potted seedlings have also produced high rates. But it can be shown that a large stand of trees cannot possibly maintain these rates, for to do so would involve many times the available energy. The isolated tree can get additional energy by absorbing reflected radiation and by picking up heat advectively from the air. The forest stand cannot.

It is under conditions of drought, when surface soil moisture is largely exhausted, that the deep-rooted forests are able to outdo the grasslands; for they can tap deeper layers of the soil, and so supply the demands of their leaf-zone longer. But otherwise, the meteorological factor dominates and the influence of vegetation type is of secondary importance. The logic of these paragraphs is the logic of the principle of the conservation of energy; it will not tolerate much argument.

A word is necessary about interception, which is of considerable importance in forests. From the point of view of the climatologist it matters little whether the water evaporating from a plant comes from the soil via the root system, or is merely intercepted rain. Both processes require the same quantity of energy, and both constitute evapotranspiration. It is true, of course, that the intercepted water will not have figured in the physiology of the plant; but, supposing that soil moisture is not actually at the wilting point, the energy consumed in evaporating the intercepted water would otherwise have been used to evaporate transpired water. In other words, intercepted rainfall is *not* lost to the plant; it must afford relief to the drain on soil moisture.

Thus, to sum it up, we can fairly claim that evapotranspiration is the key process in the exchanges between earth and atmosphere. Any effective system of climatic classification in forest or grassland regions must necessarily seek to express this process and to use it as the central parameter. Even Köppen's crude aridity factor, like those of Lang, de Martonne, Szymkievicz, Emberger, and others, attempted to express the balance between rainfall and "evaporation", without being too clear about what evaporation is actually being considered. But the importance assigned to evaporation by these writers simply considered the mass exchange; water evaporated was water lost to the soil, which would have to be replenished. Important also, however, is the role of evaporation in the energy balance of the surface, and it is this aspect that is emphasized here because of its novelty.

Precipitation is easily measured by means of rain gauges and has been recorded in most settled areas of the world. It is not easy to measure evapotranspiration however; in fact, no weather service in the world yet determines this important element and the little that we know about its distribution has been pieced together from various scattered determinations. So many difficulties exist, however, that it is still necessary to refer to other climatic data in order to determine the distribution of potential evapotranspiration.

The most reliable measurements of evaporation and transpiration which can be related to climatic elements in an effort to obtain a valid and practical empirical relationship are based on the monthly or seasonal data from irrigation and drainage projects and on daily observations from carefully operated evapotranspirometer tanks. Thornthwaite has found that when adjustments are made for variations in day length there is a close relation between mean temperature and potential evapotranspiration. Through study of the available data he produced a formula that permits the computation of potential evapotranspiration for any place whose latitude is known and for which temperature records are available. The formula is given and its use described elsewhere.[10] Work is proceeding in several places toward the development of a new formula that is based on physical principles; in the meantime, the present empirical formula is being widely used in various water balance studies.

[9] THORNTHWAITE, C. W., and others. Micrometeorology of the surface layer of the atmosphere, the flux of momentum, heat, and water vapor. *Publications in Climatology*, The Johns Hopkins University Laboratory of Climatology, vol. VII, no. 2, 1954, pp. 359-161.

[10] THORNTHWAITE, C. W. An approach toward a rational classification of climate. *The Geographical Review*, vol. 38, 1948, pp. 55-94.

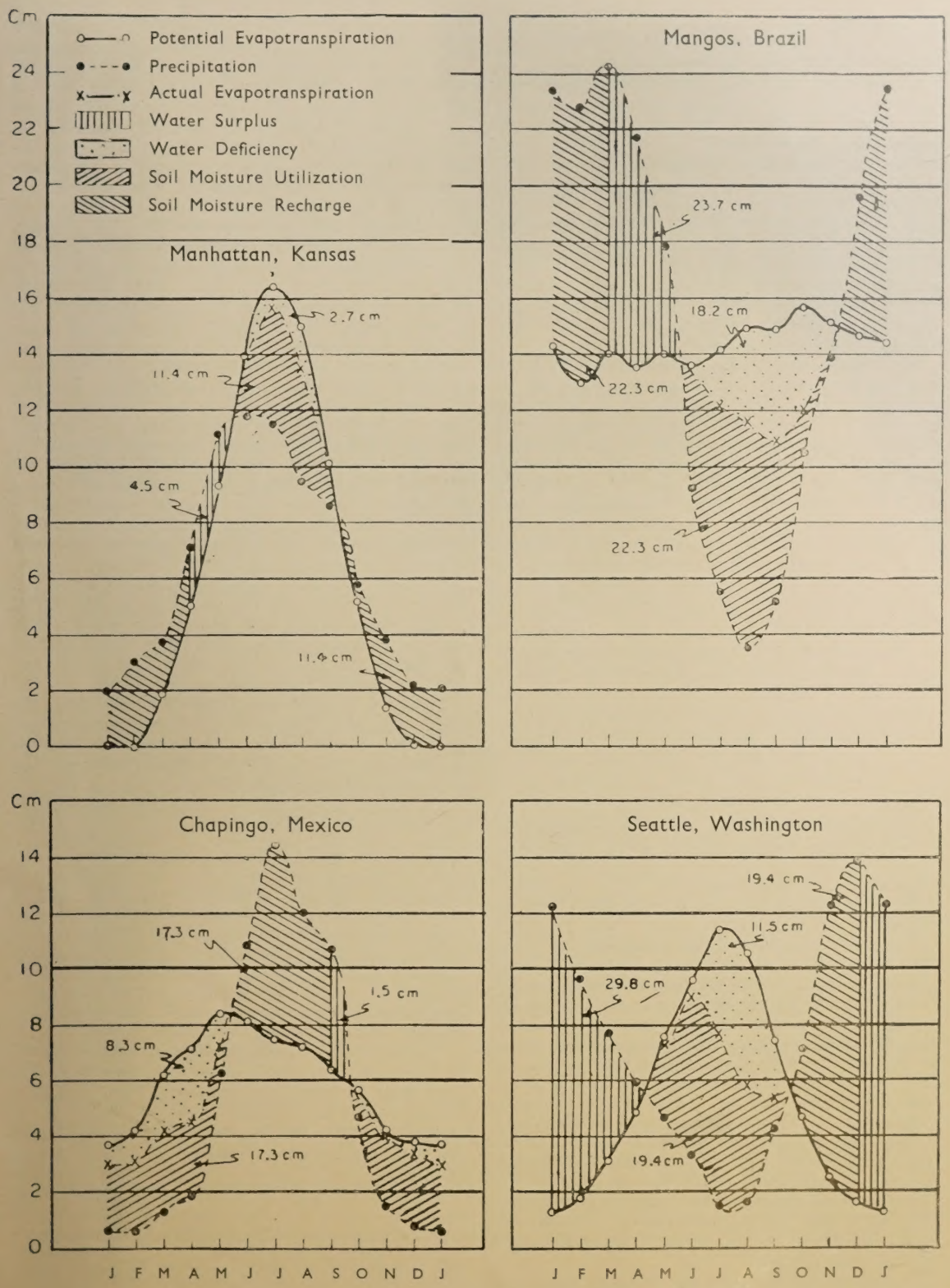


FIGURE 1. – *March of precipitation and evapotranspiration at four selected stations.*

The 1948 Thornthwaite classification

Thornthwaite's first world classification of climate was presented in 1931-1933.[11] It differed from earlier attempts by others in that it assigned the major role to the moisture factor. In 1948 he proposed an entirely new system based fundamentally on the ideas presented above.[12] He assigned the central place in this new classification to the *potential evapotranspiration* (PE), which he defined as the evapotranspiration that would occur from a vegetation-covered surface if soil moisture conditions were adequate for unrestricted transpiration. Work has been continued on this system since its first publication not only by the present authors but also by climatologists, biologists, and agriculturists throughout the world. Certain improvements have been worked out and adopted and others are in prospect.

When the potential evapotranspiration is compared with the precipitation and allowance is made for the storage of water in the ground and its subsequent use, periods of moisture deficiency and excess are clearly revealed and an understanding of the relative moistness or aridity of a climate is obtained. In some stations, precipitation is always more than the evapotranspiration so that the soil remains full of water and a water surplus *s* occurs. In other places, month after month, precipitation is less than potential evapotranspiration, there is not enough moisture for the vegetation to use and a moisture deficit *d* occurs. Stations with both wet and dry seasons, or with cold seasons of low water-need, normally show:

1. a period of full storage, when precipitation exceeds water-need and a *moisture surplus*, *s*, accumulates;
2. a drying season when stored soil moisture and precipitation are used in evapotranspiration, storage is steadily diminished, the actual evapotranspiration falls below the potential and a *moisture deficiency*, *d*, occurs;
3. a moistening season when precipitation again exceeds water-need and soil moisture is recharged.

The values of *s* and *d* can be computed during the budgeting.

It was originally assumed for convenience only that the root zone of the soil contained a maximum of 10 cm. of water in storage when fully moistened and that this moisture would be used at the potential rate as long as any of it remained. Actually, it is known that the moisture holding capacity of the soil available for use by the roots may be much greater than 10 cm. and that, as soil moisture is utilized, the rate of evapotranspiration will diminish. Recent work[13] suggests that at least 30 cm. depth of water will be available for use by deep-rooted mature plants in most normal soils and that the evapotranspiration rate which diminishes as the soil dries is proportional to the amount of water in the soil. When the soil moisture is reduced to 50 percent of capacity, the actual evapotranspiration rate will be only 50 percent of the potential rate. Although the two procedures give somewhat comparable values of actual evapotranspiration, water surplus, and deficit, as would be expected from a consideration of the assumptions themselves, the new procedure is preferable since it is more realistic than the older empirical one and depicts more exactly the processes going on in nature.

Using the new procedure it is possible to work out a water balance sheet from climatological data alone showing at all times the soil moisture condition and providing values of moisture surplus and deficiency. Figure 1 compares the precipitation with both potential and actual evapotranspiration at four selected stations while Table 3. gives the water balance computations for two of them. The various operations indicated in Table 3. are relatively straightforward. When the soil moisture is at field capacity, actual and potential evapotranspiration are the same, and all precipitation in excess of the potential evapotranspiration is realized as water surplus. When precipitation does not equal potential evapotranspiration, the difference is made up in part from soil moisture storage; but as the soil becomes drier the part not made up is larger. This is the water deficit, the amount by which actual and potential evapotranspiration differ. The soil moisture storage change cannot be determined directly but must be obtained from an appropriate table.

Finally a moisture index, Im, is derived from the relationship of *s*, *d*, and PE, all three quantities being given their *annual* values. This index is the basis for the division of the world into moisture provinces. The divisions suggested are as follows:

	Moisture Province	*Moisture Index (Im)*
A	Perhumid	100 and above
B_4	Humid	80 to 99.9
B_3		60 to 79.9
B_2		40 to 59.9
B_1		20 to 39.9
C_2	Moist subhumid	0 to 19.9
C_1	Dry subhumid	−19.9 to 0
D	Semiarid	−39.9 to −20
E	Arid	−60 to −40

The moist and dry climates are thus separated by the moisture index of zero.

The second index used to define climatic provinces is the annual PE itself. Extensive research at the Laboratory of Climatology has shown that the growth of cultivated crops is highly correlated with the accumulation of PE. For this reason, the annual PE can be regarded as a sort of growth potential for the region.[14] Whether an equally high correlation will ultimately be established with forest vegetation remains to be seen

[11] THORNTHWAITE, C. W. The climates of North America according to a new classification. *The Geographical Review*, vol. 21, 1931, pp. 633-655.

THORNTHWAITE, C. W. The climates of the earth. *The Geographical Review*, vol. 23, 1933, pp. 433-440.

[12] THORNTHWAITE, C. W. An approach toward a rational classification of climate. *The Geographical Review*, vol. 38, 1948, pp. 55-94.

[13] THORNTHWAITE, C. W., and MATHER, J. R. The water budget and its use in irrigation. Manuscript prepared for the U. S. Dept. of Agric. Yearbook 1955.

[14] THORNTHWAITE, C. W. Climate in relation to planting and irrigation of vegetable crops. *Proceedings of the 17th International Geographical Congress*, Section on Climatology, August 8-15, 1952. Preprinted, pp. 46-51. Also, *Publications in Climatology*, The Johns Hopkins University Laboratory of Climatology, vol. 5, no. 5, 1952.

TABLE 3. — WATER BUDGET FOR SELECTED STATIONS
(in centimeters)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANNUAL
	Seattle, Washington												
Potential evaporation	1.3	1.8	3.1	4.9	7.6	9.6	11.4	10.5	7.4	4.7	2.5	1.6	66.4
Precipitation	12.3	9.7	7.8	6.0	4.7	3.4	1.5	1.7	4.3	7.1	12.3	13.9	84.7
Difference	11.0	7.9	4.7	1.1	−2.9	−6.2	−9.9	−8.8	−3.1	2.4	9.8	12.3	
Storage change[1]	0.0	0.0	0.0	0.0	−2.8	−5.1	−6.2	−4.1	−1.2	2.4	9.8	7.2	
Soil moisture storage	30.0	30.0	30.0	30.0	27.2	22.1	15.9	11.8	10.6	13.0	22.8	30.0	
Actual evaporation	1.3	1.8	3.1	4.9	7.5	8.5	7.7	5.8	5.5	4.7	2.5	1.6	54.9
Water deficiency	0.0	0.0	0.0	0.0	0.1	1.1	3.7	4.7	1.9	0.0	0.0	0.0	11.5
Water surplus	11.0	7.9	4.7	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	29.8
	Manhattan, Kansas												
Potential evaporation	0.0	0.0	1.9	5.1	9.3	13.9	16.4	15.0	10.1	5.2	1.4	0.0	78.3
Precipitation	2.0	3.0	3.8	7.1	11.1	11.7	11.5	9.5	8.6	5.8	3.8	2.2	80.1
Difference	2.0	3.0	1.9	2.0	1.8	−2.2	−4.9	−5.5	−1.5	0.6	2.4	2.2	
Storage change[1]	2.0	3.0	1.2	0.0	0.0	−2.2	−4.2	−4.0	−1.0	0.6	2.4	2.2	
Soil moisture storage	25.8	28.8	30.0	30.0	30.0	27.8	23.6	19.6	18.6	19.2	21.6	23.8	
Actual evaporation	0.0	0.0	1.9	5.1	9.3	13.9	15.7	13.5	9.6	5.2	1.4	0.0	75.6
Water deficiency	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.5	0.5	0.0	0.0	0.0	2.7
Water surplus	0.0	0.0	0.7	2.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5

[1] Soil moisture utilization diminishes as the soil moisture storage becomes less.

The thermal provinces defined by means of PE values are given below:

Thermal Province		*Annual PE*
E	Frost	0 to 14.2 cm.
D	Tundra	14.3 to 28.5 cm.
C_1	Microthermal	28.6 to 42.7 cm.
C_2		42.8 to 57.0 cm.
B_4	Mesothermal	57.1 to 71.2 cm.
B_3		71.3 to 85.5 cm.
B_2		85.6 to 99.7 cm.
B_1		99.8 to 114.0 cm.
A	Megathermal	> 114.0 cm.

Thus a single parameter, annual potential evapotranspiration, because of its dependence on the energy balance, is made to serve in both the moisture and thermal indices. It is worthy of emphasis that the indices which define these "provinces" also specify at every point a thermal growth potential and the degree of moistness or aridity of the climate. In other words, the indices are continuously distributed about the earth, and do not exist merely along boundaries.

Correlation with forest distribution

The task of correlating the indices of the Thornthwaite classification with observed vegetation distribution and with soils over the earth has hardly begun. The graphical representation of the patterns of distribution of both vegetation and soil as related to climate presented in Figure 2 is adapted from Thornthwaite's 1931 classification. Eastern United States is made up almost entirely of humid climate and together with southeastern Canada, comprises one of the largest humid regions in the world. Within this region several distinct forest types have developed, in part, due to variations in the thermal index but largely because of variations in the moisture index. The humid climate exhibits a wide range in effective moisture between its subhumid and perhumid boundaries and it has accordingly been divided into four subregions. Within each of these subdivisions there is a northern and a southern zone. The forest types associated with these climatic regions are approximately as in Table 4.[15]

TABLE 4. — MOISTURE SUBDIVISIONS OF HUMID CLIMATE, MOISTURE INDICES, AND CHARACTERISTIC FOREST TYPES IN NORTHERN AND SOUTHERN ZONES, UNITED STATES

Climate	Moisture Index	Northern Zone	Southern Zone
B_4	80 – 99.9	Spruce – fir	(absent in eastern U.S.)
B_3	60 – 79.9	Birch – beech – maple–hemlock	Oak – chestnut
B_2	40 – 58.9	Beech – maple	Oak – pine
B_1	20 – 39·9	Oak – hickory	Oak – hickory

The moisture factor, and hence the moisture index, is of importance principally in temperate and tropical latitudes. In the economically valuable coniferous forests of the sub-arctic, thermal control appears to outweigh the significance of moisture. In a recently published series of articles Hare has shown that the broad physiognomic subdivisions of the Boreal Forest

[15] THORNTHWAITE, C. W. *Atlas of Climatic Types in the United States* 1900-1939. U.S. Dept. Agri. Misc. Pub. 421, 1941, 7 pp. 96 plates.

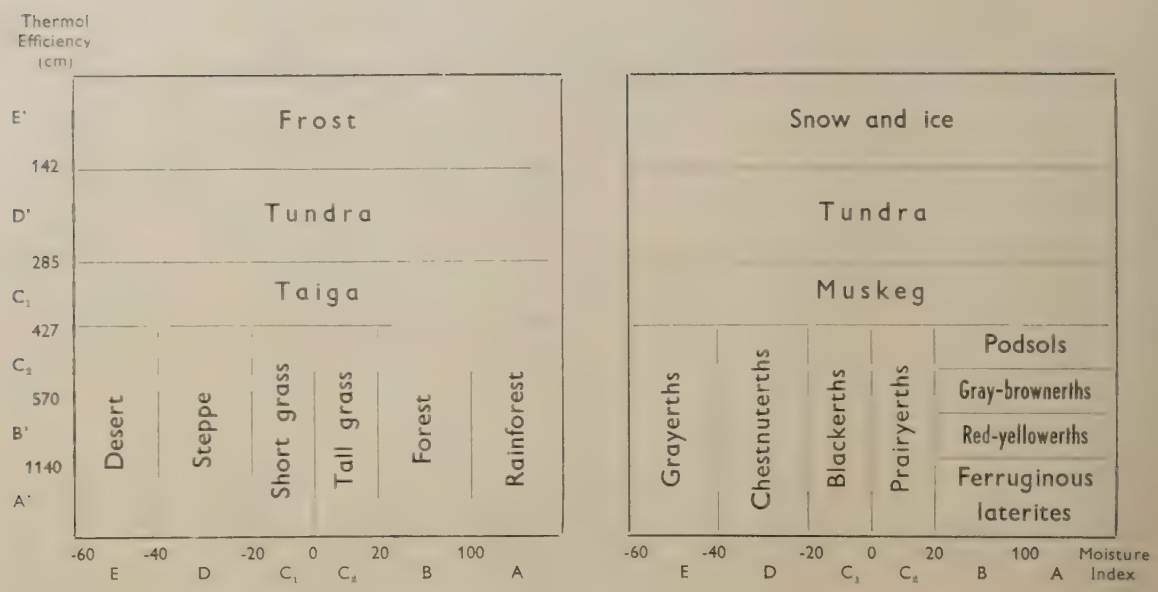


FIGURE 2. *Graphical representation of relation between climate, vegetation and soil.*

are highly correlated with the distribution of annual PE.[16] He suggests these divisions:

TABLE 5. — CORRELATION OF CLIMATE AND VEGETATION OF BOREAL FOREST

Forest Sub-Zone	Annual PE (cm)	Vegetation
Tundra		Tundra
	31	
Forest-tundra		Tundra on interfluves; woodland in valleys.
	35	
Woodland		Predominantly *Cladonia*-rich open woodland; closed-crown forest in isolated groves.
	42	
Forest		Closed-crown forest occupying most of the mesic sites.
	52	
Mixed temperate forests		Forest dominated by non-Boreal species, typically deciduous broadleaves.

The attempts at correlation of climate and vegetation that are presented in the foregoing paragraphs are highly tentative, and the authors will warmly welcome the collaboration of readers of this paper in establishing firmer and more useful relationships. Actually, since the development of climax vegetation formations and of mature soil types are most closely related to the march of soil moisture, we feel that the present Thornthwaite classification represents a step in the right direction. It is also reasonably certain that no system of classification exists, that is more soundly based. In particular, in establishing climatic analogues for the guidance of programs of exotic plant introduction, the indices described above seem likely to be of considerable value.

As part of a long-time program which the Laboratory of Climatology has under way,[17] climatic maps are being prepared which include precipitation, potential evapotranspiration, water surplus, water deficit, and the moisture regions for all parts of the world on a scale that is consistent with the density of the climatic network. Maps of several areas have been made on a scale of 1 : 1,000,000. Maps of the entire continent of Africa have been completed on the new American Geographical Society base map in scale 1 : 3,000,000. It is anticipated that the mapping of the entire earth will be completed within a short time.

These maps may help meet the expressed needs of silviculturists in FAO which were quoted earlier in this paper, as well as such groups as the Advisory Committee on Arid Zone Research and the Humid Zone Research panel of UNESCO. It is probably quite important that these new maps be made available to all workers who have need for climatic information.

Since it is clear that whether grasses and other herbaceous plants occupy an area alone or share it with trees and shrubs depends on the soil moisture regime, it is necessary to go further than merely to obtain a useful and rational climatic classification. It is necessary to develop more fully the water balance approach, to determine the actual influence of soil moisture on climax vegetation formations and to make maps of these active

[16] HARE, F. K. The Boreal conifer zone, *Geographical Studies*, vol. 1, no. 1, 1954, pp. 4-18.

[17] This program is supported in part by the Geography Branch, Office of Naval Research, United States Navy.

controls of vegetation distribution. Thus, foresters should not hope for a complete solution to problems of plant distribution in a "standard" climatic classification but should seek information on the soil moisture regime, and understand the importance of periods of moisture deficiency and surplus in the formation of vegetation complexes. Maps of the distribution of these latter elements would be more important than conventional maps of climatic regions.[18]

Finally, the authors express the hope that the conceptual framework of forest ecology will approach that of the climatologist more closely in the future. It is clear that such a convergence already exists. Thornthwaite has pointed out that the detailed texture of local climates, based on variations of slope, soil characteristics, roughness, and albedo requires what he calls a *topoclimatological* approach.[19]

This approach, in effect, an effort to bring climatology down to earth, has an obvious parallel in the "site" concept of the forest ecologist. Indeed, it might be possible to go so far as to say that the two ideas are opposite sides of the same coin. On the obverse, there are climatic influences of the moisture, energy and momentum exchanges, and on the reverse are the biotic and edaphic controls of relief, aspect, slope, soil texture and the composition of the vegetation. If the topoclimatological approach is pursued, there is little doubt that both groups, climatologists and forest ecologists alike, will get far closer together in their thinking than they are today.

[18] THORNTHWAITE, C. W. Grassland climates, *Publications in Climatology*, The Johns Hopkins University Laboratory of Climatology, vol. 5, no. 6, 1952.

[19] THORNTHWAITE, C. W. Topoclimatology, *Proceedings of the Toronto Meteorological Conference*, 9-15 September 1953, AMS and RMS, 1954, pp. 227-232.

SUN HARNESSED FOR COOKING

Sunshine may be the cheapest available "fuel" for millions of families in underdeveloped areas who cannot afford shiny new stoves or even wood.

A solar energy scientist at New York University has conceived a practical, economical stove that cooks by sunlight. The Ford Foundation is backing the project with a grant to the Research Division of New York University's College of Engineering for detailed research and development of a sun stove.

The project as reported to FAO ranges beyond engineering aspects. Concurrent with the scientific development of the cooker, therefore, the social, psychological and economic effects of introducing and integrating such a new device into the customs of the peoples for whom it is intended will need to be determined.

Important also, and another area of the study, is an industrial and materials survey of these countries. What materials are available for incorporation into the sun stove? What skills are available for its manufacture? What is the country's industry potential for its mass production?

Cost is a crucial factor in introducing solar cooking to underdeveloped areas. The most successful solar cooker developed to date involves a costly parabolic reflector.

The new stove design eliminates the need for parabolic reflectors. Furthermore, it has the advantage of retaining cooking heat for an hour or so after the sun has gone down, the time when the evening meal is cooked and its heat-storing capacity largely eliminates the necessity of changing the position of the stove frequently to catch direct sunshine.

The stove is a closely insulated box, roughly triangular in shape. Four ordinary flat mirrors fan out from the tilted face of the stove. At the rear of the stove is a removable drawer in which the food is placed.

The mirrors reflect sunlight down through the tilted face of the stove, concentrating it in the interior, which is filled with special heat-absorbing chemicals. The principle of the stove is "heat of fusion", or "heat of transformation." All materials when melting require large amounts of heat to change from solid to liquid forms. During melting, the temperature of the material does not change but remains at melting point. The problem in the solar stove and other heat storage devices is to devise materials with relatively high heats of fusion. In the sun stove, therefore, the sun's heat produces a succession of changes in the heat-storage salts from solid to liquid state. The changes give off the heat used for cooking.

Preliminary models of this stove developed temperatures up to 300° F(148° C) on days when the outdoor temperature was under 70° F (21° C). From 250° to 300° F (120°-148° C) is considered ample for average cooking operations. Higher temperatures needed for frying and browning have been developed in the stove on clear days. The areas for which the stove is intended enjoy direct sunlight most of the year.

The New York University research group believes their stove can be developed so that it can be manufactured to sell for $ 5. The least expensive solar cooker devised to date sells for about $ 16. Besides cost and conformity to local cooking customs the stove will be designed to meet these requirements: durability, ease of operation and cleaning; simplicity and portability; ability to operate in early evening, and little attention required during cooking.

Japanese Experience in Protective Planting

Erosion Control in Mountainous Areas

by Masataka Ohmasa
Director, Government Forest Experimental Station, Meguro, Tokyo

A constant struggle is waged in Japan against erosion and landslides on hill slopes laid waste by man or devastated by exceptionally heavy rains. The general aim is to re-establish a vegetative cover as rapidly as possible and if this can include useful tree species, so much the better. There is no exact standard method laid down for carrying out operations because the topography, soil and local climate with which the forester has to contend vary from place to place. But the following practices are those most commonly employed in Japan.[1]

Preparation of the Site

The site to be re-clothed with vegetation is prepared in two stages. The surface of the eroded land is first evened off; then it is stabilized. But in the case of a hillside with a slope of 25 degrees or less and with a fairly regular surface, special preparation of the site is regarded as unnecessary. However, wherever there is a tendency for the debris accumulated on the lower slopes of a hill to become sodden from rain or melting snow and threaten a landslide, preventive measures are taken as soon as the accumulation has reached a depth of 3 meters or more, stone or wicker revetments or cylinders of wire being embedded in the ground (hence being called "buried works").

Restoring the slope of a hill which has been cut up by erosion, torrents or by a landslide, is a necessary preliminary to the turfing or terracing operations which will follow. Material obtained from levelling the surface is used to fill the depressions and fissures cut in the hillside, the work starting at the top of the hill and proceeding down to the foot. Care is taken not to interfere with any patches still carrying natural vegetation.

Site preparation and levelling are carried out by manual labor, using picks and shovels. Sometimes use is made of explosives, and mechanization of the operations, employing rock-drills and other equipment, is now being studied.

Once the surface of the hillside has been satisfactorily levelled, it is terraced by much the same methods as are used in other countries. The hillsides that require treatment in Japan are, however, usually fairly steep, so that the terracing takes on the appearance of a series of ascending steps. The terraces are made stable either by turfing, by simple terrace works, or by masonry or wicker revetments. (Figure 1).

[1] An extract from a contribution to a forthcoming FAO Forestry Development Paper dealing with "Tree Planting Practices for Temperate Asia".

Figure 1. *A variety of terracing methods, using masonry, fascines and wicker work.*

Figure 2. *Turfing of steps, with seedlings planted on the terrace.*

FIGURE 3. *Simple terracing.*

FIGURE 4. *Blanketing a whole slope.*

Turfing

This method is usually employed where there is a slope of 30 degrees and the ground is fairly hard. The horizontal steps vary from 1.5 to 3 meters in height and 0.6 to 1 meter wide, according to the slope of the hillside.

Turfs are placed at the base, on the face and on the top of the outer edge of the step, and made compact with earth taken from the inner edge, as shown in Figure 2. To prevent the turfs on the face of the step from slipping, they are usually braced by shoots of *Shinoarundinaria sp.* and stakes of *Salix spp.*, driven some 15 centimeters or more into the ground as supports.

The turfs are, as a rule, cut from natural grass cover in a forest area, and are 20 to 27 centimeters long, 30 to 40 centimeters wide and 10 centimeters thick. They survive quite well provided the ground into which they are transplanted has a fair moisture content. Results are poor in places where there is much seepage or considerable dampness.

Simple terrace works

These are only effective where there is a reasonable depth of soil and the slope is moderately gentle. Steps are made in the hillside about 0.5 meters wide at intervals of about 1 meter. The top of the steps is hoed to a depth of some 15 centimeters to make a tilth. Along the outer edge of the step *Torreya nucifera* or *Lespedeza bicolor* are planted in parallel strips and behind these tree seedlings are planted. (See Figure 3.)

Various materials are used to protect the front face of the step: turf, straw bundles, fascines, stone, logs or poplar stakes. Frequently some parts of a hillside, otherwise requiring turfing, can be treated by simple terracing.

Wicker work and masonry

This is employed on slopes that are too steep for turfing to hold. Wicker work prevents the soil from slipping and holds the slope firm. It is usually about 20 centimeters high, although in rare cases it can be as much as 50 centimeters. It is held by stakes that are driven into the ground at an appropriate angle.

Masonry means dry-built stone walls constructed against the hillside, and is used where the ground is very damp or where evening-off is difficult to perform, owing to rough hard ground unsuitable for terracing. Masonry revetments are also constructed to prevent earth filling or spoil from sliding down the slope. Masonry is apt to be expensive, however, unless there is a plentiful supply of stone available in the immediate neighborhood. Walls are sloped at a gradient of between 3:10 and 5:10, and vary between 0.7 to 2 meters in height.

In places where the ground is too loose owing to weathering or because it is frost-bound, terracing is usually unsuccessful and it is necessary to blanket the whole hillside. The slope is covered with fascines, straw, *Torreya nucifera*, etc. or with a network of corded bundles of the same materials, held down with stakes. (See Figure 4.)

Depressions and gullies on hillsides where water flows down are very prone to erosion and have to be specially protected. Channels are constructed which may be either of a trapezoid or arc cross-section. The former type of channel in stone is used where there is a great deal of water and an arc of turfs where the flow is less. Both kinds of channel are normally roofed with stone or turfs. The bed of the lower parts of the channels is usually lined with solid stone work, similar to dam construction.

FIGURE 5. *Hillside drainage channels.*

Main channels are mostly provided with stone benches at suitable intervals, of a sufficient height to control the flow of water. As a general rule, a fanwise pattern of branch channels, connected by transverse terraces, runs into the main channel. (See Figure 5.)

These channels serve to drain off the surface water, but sometimes it is also necessary to drain off the subsoil water. In this case, the usual practice is to bury closed conduits at an appropriate depth in the ground. A ditch is dug and one or two cylinders of wire laid in it and covered over with gravel until the ditch is filled. The cylinders are secured by wooden stakes driven in at intervals of about 2 meters. If it is not too costly, the ditch is sunk deep enough to reach rock level, otherwise conduits which are merely ditches filled with buried fascines or gravel must often suffice.

PLANTING AND SEEDING

Species used

Amongst the tree and grass species favored for erosion control in Japan, the pines *Pinus densiflora*, *P. thunbergii* and *P. rigida* have all been used from ancient times. They are unsuited for the thin, dry soil of the upper parts of hill slopes, but are useful for the lower slopes and valleys. Alders (*Alnus japonica*, *A. hirsuta*, *A. firma* and *A. multinervis*) are widely used, especially to act as nurse trees to the pines. *Robinia pseudoacacia* is also widely planted at the foot of slopes, beside a stream or river, or on embankments. The trees grow rapidly and provide a very good check against soil slip, while they produce useful firewood and wood for charcoal. Oaks, particularly *Quercus dentata*, have deep roots and therefore hold the soil excellently, but they are of slow growth. They are usually put in under a cover of pines and alders.

Populus spp. and *Juniperus* spp. grow quickly and are commonly used to protect river banks and stream beds. *Prunus serrulata* takes root well and grows even on sharply sloping bare ground. *Castanea crenata* grows rapidly and retains the soil very well. *Lespedeza bicolor* is effective where it is difficult to establish cover by ordinary planting. Other useful species are *Amorpha fruticosa* and *Acacia* spp.

Among the grasses used are *Miscanthus sinensis*, *Spodiopogon cotulifer*, *Artemisia vulgaris*, *Indigofera pseudotinctoria*, *Microles pedeza striata*, and more recently *Festuca elatior var. arumdinacea* and *Eragrostis curvula*.

Planting

Actual planting is usually carried out by setting out seedlings on the terraces, direct seeding being employed only where planting is likely to prove a failure.

Planting time varies with locality and with the general progress made in site preparations, but it is generally done in the spring, from February to May, or, in localities where autumn planting is possible, after the leaves have fallen.

The planting hole is made 25 to 30 centimeters wide and deep, and the seedling is planted at a fair depth. The number of seedlings planted per hectare is at least 5,000 to 6,000 and more often 10,000 to 12,000, giving 15 to 20 trees per 10 meters of terrace, although the spacing varies with the species and the particular site. Two-year-old seedlings, not transplanted, are used in the case of the pines, usually mixed with *Alnus firma*. For the latter and *Robinia*, one-year seedlings are used. When vegetative cover has to be restored on denuded land as rapidly as possible, woody shrubs are closely planted between the trees and sometimes grasses are sown or planted as well. The slopes between terraces may also be planted, and the outer edges of the terraces often protected by planting *Torreya nucifera*.

As fertilizer, ammonium sulphate, calcium superphosphate, straw ashes, wood ashes and, recently, solid or granular chemical fertilizers are commonly used. The usual dosage is 30 to 60 grams per tree. Good results have been obtained by laying compost and solid manure, the effectiveness of which is long lasting, in ditches 20 to 30 centimeters wide.

Seeding

Direct seeding on the terraces is carried out with a mixture of seed, calcium superphosphate, ammonium sulphate and soil mulch spread evenly and then covered with earth. To prevent the ground from becoming too dry, a thin layer of straw is spread over a seeded surface.

To seed a terrace with *Lespedeza bicolor*, a mixture of seed (treated to hasten germination), ashes and calcium superphosphate is broadcast on the terracing behind the *Torreya nucifera*.[2]

Seed of perennials and shrubs is also frequently sown on the slopes between terraces. In this case, a similar mixture is scattered in raked lines or spots, and the seeded portions are then covered with straw. Where the slope is gentle, the seed mixture may also be deposited in holes 20 centimeters in diameter and 5 centimeters

[2] A mixture of 1.35 kilograms of seed, 7.5 kilograms of ash and 7.5 kilograms calcium superphosphate is sufficient for 180 meters of terrace.

deep, cut one per square meter, and again covered with straw.

Where the ground is very poor or has been greatly denuded, no attempt is made to plant up idrectly with seedlings. The method followed is to try to establish a natural succession of vegetation, to create an environment in which forest trees can later develop. The method is as follows:

Firstly, broken and loose earth is scraped off the slope into depressions in the hillside or down to the valley, leaving a firm smooth surface for seeding. At key points, turfed channels and stone revetments are constructed. Then, horizontal steps 20 to 30 centimeters wide are cut in the slope and spaced at intervals a little less than the length of the straw sheaves which will be used to cover the slope. These steps afford a foothold for the planters and serve as the points where the ends of the straw covers meet and can be tightly pressed down with earth to hold surface soil and check rainfall run-off. On the surface thus prepared, numerous small holes are made with a hoe, or, where the slope is very steep, shallow horizontal lines are raked into the slope to hold the seed mixture which is to be used.

This mixture has seeds of hardy and less tolerant plant species and plants of spreading and erect growth habits mixed together, with forest tree seed added. The following is a common mixture for the latter: *Podocarpus nagi*, *Arundinella hirta*, *Cyphopogon goeringii*, *Lespedeza cuneata*, *Lespedeza bicolor*, *Alnus hirsuta*, *Pinus densiflora*, *Pinus thunbergii*, and *Quercus variabilis*. These tree seeds are first put into a cloth bag and soaked in water to force germination.

The whole seed mixture is mixed with wood ashes of equal or double quantity and then further mixed with a combined fertilizer (calcium superphosphate, ammonium sulphate, and wood ashes) and sandy loam, exact proportions having been worked out for the various components and for the quantities required per surface area to be seeded.

The whole mixture is eventually scattered on the slope and pressed down with a tamping board. Immediately after an area has been seeded, specially selected forest tree seed, such as *Quercus variabilis* and *Q. acutissima*, may be sown in 2 centimeter holes at a spacing of one seed per square meter. Then, thin layers of straw are laid over the surface, the ends being packed down securely with earth.

If forest tree seed is not sown directly with the first plant mixture, the tree species are introduced by planting in the year following the establishment of a vegetative cover.

" Vegetation blocks "

An ingenious method of combining the advantages of both planting and seeding has been devised by an officer of the Maebashi Regional Forestry Office. It involves the use of " vegetation blocks " which can be set out either on a terrace or on a slope, and result in the rapid establishment of a vegetative cover. (See Figure 6.)

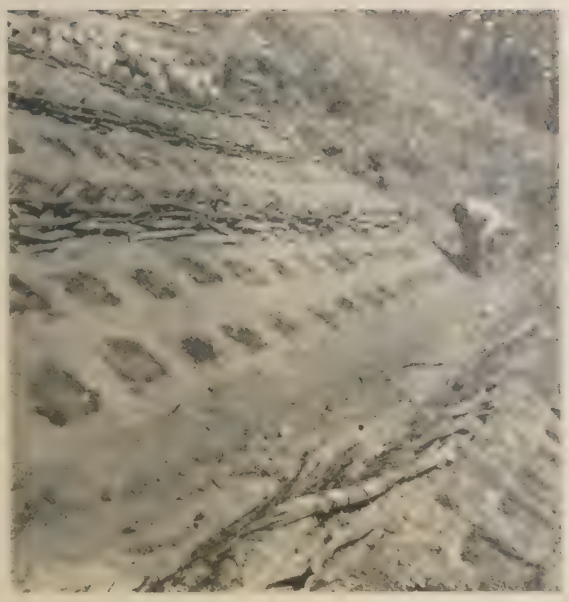


FIGURE 6. *" Vegetation blocks " set out on a slope.*

To make the " block ", a composite mixture is kneaded together and then compressed in molds to produce a " brick " 33 centimeters long, 20 centimeters wide and 2 centimeters deep. The mixture is composed of earth (graded sand and soil with a considerable amount of A-horizon), fertilizer (compost, ammonium sulphate, calcium superphosphate, fiber of straw and dried grass), clay and water.

Five holes, 2 centimeters in diameter, penetrate the block (made at the time of molding) to allow stakes to be driven through the block to anchor it to the ground. At the same time the upper surface of the block is pitted with 300 small holes (top diameter, 6 millimeters; lower diameter, 4 millimeters; depth, 5 millimeters).

A seed mixture with wood ashes, prepared in previously determined proportions suited to the particular locality where work is to be carried out, is spread over the top surface of the block, thus filling up the many small pits, and then the block is lightly pasted over with a clay and water mix.

Finally, the individual blocks are set out on the hill slope and staked down with stakes of *Dentzia crenata* and poplar which themselves in due course set root and sprout.

Wood Burning

by H. G. Winkelmann,

Director, Swiss Central Forestry Office, Solothurn, Switzerland

Wood still remains a major source of fuel for domestic heating and cooking. For the most part it is wastefully burned although it is comparatively simple to design equipment adapted to the specific combustion properties of wood, so as to get the most out of its calorific value. This has been done for other solid fuels as their relative scarcity and expense provide the incentive, and there is no technical reason why the same should not be done for wood. The author has prepared an information paper for FAO on the techniques of wood burning, and this will in due course be made available for distribution. A brief extract from this bulletin is paraphrased below.

The hearth was always the family gathering place, and the open hearth fire, the oldest heating system, has survived to the present day, right into this technical age. The open fireplace is still a normal fixture in town houses and even apartment buildings in many countries, despite the installation of modern central heating systems, and in rural areas and in tropical countries having cold winters it is still often the only method of heating. Its value today in most urban centers lies rather in the note of intimacy it gives to the home rather than to its efficiency as a heating unit.

An advance on the open fire was to enclose the flame completely, the result being the stove or furnace. This was originally a thick walled structure made of clay and stones, with an opening through which the smoke reached the exit of the room. When such stoves gradually came into general use, the cost of operating them led to their improvement. They were then made with plates of stone or earthenware tiles, set on supports and fitted with a closing door. Next there was added an enclosed flue emerging through the roof. The addition of the chimney was a later stage when principles of combustion were better understood. Eventually there came the large modern stove with its long flues and smoke pipes.

The primitive stove had no grate. In short, the practice was to burn a pile of billets in an empty space enclosed by flat stones. Because of the large excess of air, combustion was poor, the temperature of combustion relatively low and it was practically impossible to regulate heat output. Attempts were made to replace the grateless stove by one with a wrought iron base or some other such apparatus, but without much success. Yet, because of the simplicity of wood combustion, quite good results can be obtained by improving the design of the fuel chamber, the flues and the air intake. Besides, a grateless stove is always better than one with a poor grate that is too large, badly shaped or creates too strong a draft. In many places it is still thought better to burn wood in a grateless stove, but this idea is wrong. The efficiency of a grateless stove is always inferior to that of one with a good grate. The problem, however, is to find the right dimensions for the grate and to regulate the air intake accordingly. In other words, it is a question of constructing to suit the specific properties of wood.

For some uses, the grateless stove is still justified today, for example, in ovens for baking bread and in glazed tile stoves. Such stoves made to modern designs are known to have good combustion, insignificant waste and a high capacity for heat accumulation.

Features of modern stoves

To obtain the best possible results from any stove, it is essential to suit its construction to the particular properties of the fuel which is to be burned. This principle holds true especially for wood whose properties differ markedly from those of coke, coal and other solid fuels. Unfortunately, too little importance is usually attached to the peculiarities of wood, which ignites and burns so easily — a pile of billets on the ground and in a moment a fire is glowing — that no special adaptations are considered necessary.

The purpose of heating technology is to devise systems by which the most complete combustion can occur, allowing regulation of the rate of heat emission and its conduction wherever desired.

The correct way to burn wood may be deduced from its particular physical and chemical properties, which are not dealt with here. It must be sufficient to say that three factors are of cardinal importance: the dimensions of the grate, the design of the fuel chamber, and the dividing of the air intake (primary air and secondary air). No set rules can be laid down in regard to dimensions. Each apparatus has to be designed for the particular use to which it will be put, but in a general way all wood stoves should have a fuel chamber, a grate and air intakes.

Fuel chamber

The purpose of the fuel chamber is not only to hold the necessary quantity of fuel but also to allow sufficient space for the flames to burn freely. It must therefore be large enough so that the gases will have time to burn completely before coming into contact with the heating surfaces which will cool them. The junction of the fuel chamber with the narrower grate is effected by sloping lateral walls which make the lower part funnel shaped. With this arrangement, wood charcoal accumulates on the grate and covers it completely and

in a sufficiently thick layer. The fuel chamber must be slightly deeper than the billets are long.

The fire tubes and smoke flues which lead off from the fuel chamber must be placed in such a way that the heating surfaces are well exposed to the gases arising from combustion. It is a question of finding the proper solution from the standpoint of draft technology. The dimensions of the flues must be proportional to the gas content of the fuel and to the total heating surface. With wood, the flues must be lengthened by reducing their cross section near the outlet in proportion to the decrease in volume of the gases as they cool off.

Grate

The grate must be relatively small, in all cases smaller than the bottom of the fuel chamber so that the wood charcoal which forms during combustion attains a sufficient depth to cover the grate completely. The quantity of heat produced per square meter of grate must normally be as follows[1]:

Stoves	90,000-200,000 kcal/m²/h
Kitchen ranges	200,000-250,000 kcal/m²/h
Boilers	220,000-250,000 kcal/m²/h

Such heating obviously implies a draft in proportion. If the draft is too weak owing, for instance, to a very low or badly made flue, the admissible charge must be less. If the grate is too big, the temperature of the gases escaping through the flue is too high, which entails heavy losses in heat. On the other hand, too small a grate easily causes draft trouble and consequently incomplete combustion with the risk of tar deposit in the flue.

For a wood stove, the grate must be so made that the ratio of the interstices or slits to the total area is between 0.25 and 0.35. This ratio is much smaller than that for coke grates, because of the relatively low air consumption of the wood fire, and because the air intake must be arranged at two different levels.

[1] The "kcal" (kilogram calorie) of the metric system is equal to 3.968 British Thermal Units (B.T.U.)

Preference should be given to a flat grate. It should be made in such a way that the ash can be easily removed and the air have access at all points. For large stoves the grate bars should be indented or grooved on the lower surface to increase their cooling capacity.

The grate should be as deep as the billets used.

Air intake

In a wood stove the combustive air currents must be introduced at two levels:

primary - under the grate
secondary - in the flame

The primary air current reaches the wood through slits in the grate. Since it is only a part of the total quantity needed for combustion, gases are given off more slowly and combustion can be regulated more easily. Primary air, however, must be introduced in sufficient amount because, if the production of gases and consequently development of heat are kept too much in check, combustion will be incomplete.

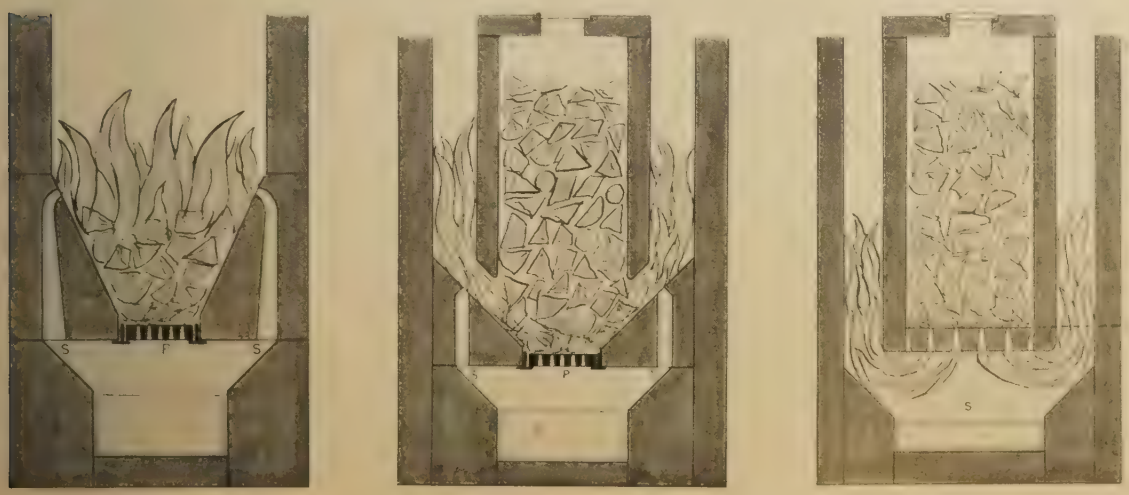
Secondary air must be preheated, then released evenly into the combustion gases above the layer of fuel so as to ignite the as yet unburnt gases. In small household stoves, secondary air, like primary air, can be drawn in through the ash box. The flues in which it is heated convey it into the fuel chamber where it emerges through regularly spaced openings. In large stoves, on the contrary, primary and secondary air are introduced and regulated separately.

There should be a specific quantitative ratio between these two air intakes. The total area of secondary air openings is one-quarter to one-third of the area of the grate slits through which primary air penetrates.

Combustion Systems

A modern heating system must not only ensure complete combustion without condensation and as high as possible a heating efficiency, but must also meet standards of convenience and cleanliness.

Left to Right. *The diagrams illustrate three methods of combustion: ascending, horizontal and descending or reversed. P signifies primary air; S, secondary air.*



To meet these requirements there is a choice of several combustion methods, depending on the kind and purpose of heating:

Ascending combustion

With this method, the simplest and oldest, the flame rises and the fire spreads throughout the layer of fuel so that the total load burns simultaneously. Hence it is not possible to obtain a continuously burning fire.

With the narrow grate and the sloping slides forming a funnel, a good layer of live charcoal is always obtained which ensures slow, easily regulated combustion. The live charcoal, closely piled, keeps burning for a long time and after a prolonged interval can still ignite a fresh charge of wood. The secondary air current which passes through the lateral flues emerges into the fuel chamber above the fuel, and mixes with the gases. The slanting sides of the specially made fire-proof stones used for the inlets and outlets for the secondary air give the funnel shape to the fuel chamber.

Horizontal combustion

The fuel chamber serves primarily as a container for the fuel while the flames mount in a second chamber. The openings between the fuel chamber and this second chamber must not be too large, so that the zone of combustion can be kept as low as possible. On the other hand, they must not be too small, otherwise there would be insufficient draft. The size of these openings must be exactly proportioned to the use conditions. The secondary air is introduced at the mouth of the fuel chamber, that is, at the narrowest part where the flames are compressed.

Primary and secondary air penetrate through the ash box door. They may enter through one and the same opening or through separate openings from the beginning. The feeding door, which should not have any rosette disc for air admission, must be airtight and sealed as closely as possible. In fact, if the air penetrates above the zone of combustion all the wood supply may ignite, which is contrary to the principle of this type of combustion.

During combustion, gases gather in the upper part of the fuel supply. If the charger door is opened before all the load has burned, the penetration of air produces a small explosion. To remedy this drawback, a bypass valve is fitted to the charger door and blocks it. Consequently, this door cannot be opened until the valve is released. In this way, explosions and the escape of smoke are avoided when the stove is recharged. In kindling, the bypass valve lets in a direct draft. It is closed when a bed of live charcoal has formed or when charging is finished.

Descending or reversed combustion

This system also ensures continuous combustion with emission of steady heat.

As the name indicates, the particular feature of this system is combustion directed downwards. Over the grate there is only the firebox with the fuel supply. The flames mount under the grate which is made of fireproof bars with narrow interstices. During combustion only the layer of fuel immediately on top of the grate burns. The flames pass through the interstices and expand in the chamber underneath where the smoke flues begin. The introduction of the combustive air is also reversed, that is, the primary air is introduced above the grate while the secondary air arrives underneath. This system guarantees good combustion because the gases pass first through the fireproof grate which is very hot. It follows that less secondary air is needed and any excess of primary air can serve as secondary air.

As in the preceding system, a bypass valve operating above the fuel supply will have to be provided. If continuous fire, that is, slow combustion, is desired, obviously the fire and ash-box doors will have to be airtight and the valve closed.

A stove of this type can only use fuel burning with a long flame, and is therefore well adapted to wood. Like all modern stoves which get a high heating capacity from the fuel used, descending combustion units require a chimney or flue in perfect condition to provide the proper draft.

Translated from an original French text.

TEACHING CONSERVATION

The International Union for the Protection of Nature has, over the past few years, with the collaboration of national educational authorities and with financial aid from UNESCO, published leaflets for use by teachers and children in elementary schools in many parts of the world.

These local adaptations of a standard prototype lesson, and a leaflet in the form of a diploma bearing the name and address of each child, are now in use in countries as widely divergent as Mexico, Italy, Greece, French Cameroons and Madagascar.

The so-called diploma is of especial interest, in its appeal to the child and by the reminder that it constitutes. Headed by a design incorporating a map of the territory on which the child can mark his home-town, and suitably framed by drawings portraying the national resources of his country, there follows space for the name and home address of the "graduate." Below this, the rest of the space is taken up with the text of a few golden rules governing the principles of conservation.

At the request of the International Boy Scouts Association, FAO is helping to write a handbook on conservation for use by the Boy Scouts Movement, and based also on the idea of a prototype which can be adapted to local conditions and needs throughout the world.

Shifting Cultivation in the Belgian Congo

by G. Tondeur
Director, Soil Conservation Mission, Belgian Congo

Extracts from a case study prepared in connection with a general FAO enquiry on shifting cultivation

In the heart of Africa on both sides of the equator from approximately 5°N. latitude to 13° 30' S., the Belgian Congo covers an area of over 2.5 million square kilometers. Its climate is wholly equatorial and tropical. Approximately half the area is under dense forest while the rest consists of fairly well wooded grassy savanna. The topography may be likened to a bowl in which the central hollow is bordered by higher plateaus. This bowl is called the Equatorial or Central Basin.

In general, the type of agriculture traditional throughout the country before the penetration of European influence can be classed as shifting cultivation. This primitive agriculture was on a bare subsistence level. In fact, there was no such thing as a produce market. Wild fruits, fish and game supplemented cultivated crops.

Under such a primitive agricultural system the individual, family or village never grew crops continuously on the same plot of ground. Cultivation alternated with very long fallow periods, and there were frequent shifts to new land, leaving used land to lie fallow. But the dwellings of the cultivators, grouped into fairly large villages, were of a more stable nature, even though they were always built of perishable material such as straw, leaves, tree branches, rammed clay or earth. The villages tended to remain while the area cultivated shifted. In fact, except for the Pygmies, who did not do farming of any sort, there were no truly nomad peoples in the Congo, although a few tribes were semi-nomadic.

Shifting cultivation is still practised in both the forest region and in the savanna, and owing to the wide range of physical conditions peculiar to these vast regions, has assumed a variety of forms. They are lumped together for convenience under the name of the "Bantu agricultural system", as the Bantus are the main ethnic group to which belong the peoples of the Belgian Congo, particularly those of the Equatorial Basin.

Reasons for Shifting Cultivation

Shifting cultivation in the Belgian Congo is not today regarded as a necessarily unsuitable type of agriculture, but rather as the inevitable outgrowth of various particular local factors. After an initial period when European settlers thought they could impose a European way of farming, the prevailing opinion has been that it is the only type of farming that conserves the soil, at least so far as present knowledge goes.

Physiographical factors

The zone under consideration here, the Central Congo Basin, has largely resulted from the progressive drying up of an inland sea called Lake Busira (old lake of the Kasai Basin). This geological phenomenon was due to the cutting through of the Crystal Mountains by the Congo River on its way to the sea. The drying up process is still continuing and many lakes such as the Tumba and Leopold II, and vast expanses of marshy forest, are remnants of this great lake.

The land exposed through the disappearance of this lake is for the most part flat. The central part, lying inside the wide sweep of the Congo River, and the western area enclosed by the Congo and Ubangi rivers, consists of low-lying, often marshy, ground raised slightly above the river level. Beyond the sweep of the Congo River and south of the Kasai River, the ground rises gradually. Some of the plateaus in this tableland formation, like the Yangambi, are now considered to be of aeolian origin, as they are apparently derived from the dunes deposited around its edges by Lake Busira during the Pleistocene period.

The outline of these plateaus has been progressively smoothed down by erosion and, in addition, gullied by the crowded watercourse network covering them so that it now appears very slightly undulating, intersected by fairly deep valleys.

In principle and by definition, the confines of the Central Basin may be considered the same as those of the equatorial forest. Thus both the climate and the climatic vegetation of the zone can be described together.

The climate is distinctly equatorial: rainfall is well distributed over the whole area, with two annual minima and maxima points, high constant humidity and temperature. Compared with equatorial regions in other parts of the world, this zone has relatively low rainfall and limited sunshine. The rains are chiefly continental and so are somewhat variable.

The annual amount of sunshine totals 1,952 hours, only 45 percent of the possible insolation.

Vegetation, naturally, consists of rain forest. It varies in appearance with local variations in soil and climate but still forms a very uniform cover over the entire zone. Apart from a few man-made clearings, this cover is unbroken except for some treeless marshy formations, a few grassy tracts of dry land and, towards the perimeter, sometimes very large strips of savanna included in the forest as marking the transition to the tropical savannas.

Generally speaking, the Basin's soils are very poor from an agricultural standpoint. The type studied most thoroughly to date is the Yangambi yellow ochre sand. Consisting of wind deposits, it forms very deep (1,000-4,000 centimeters) homogeneous strata.

The physical features make the soil very permeable. This permeability, together with the equatorial climate, abundant rains and high temperature, have caused very pronounced leaching out of plant nutrients.

The upper horizons are a sort of residual sand formed almost entirely of quartz mixed with a kaolin clay. This clay is apparently a recent product resulting from the decomposition of the more unstable minerals, accompanied by the release and leaching out of the plant nutrients.

The soils related to the Yangambi type may all be described as very poor in mineral reserves. They are acid and all the chemical constituents are concentrated in the humus-producing horizon. The latter, in a soil in good condition, has a pH of 4.1 to 4.5, and an organic carbon content of 1 to 2 percent. The total exchangeable bases rarely exceed 2 milligram equivalents per 100 grams of soil and are 70 to 80 percent calcium. Potash and, in particular, magnesia, occur in trace quantities (0.1 milligram equivalent). The P_2O_5 content ranges around 1 to 3 milligrams per 100 grams of soil. Part of the phosphates are fixed in the iron compounds and consequently cannot be utilized by plants.

The nutrient content increases with depth in proportion as the effects of leaching diminish. The top layer, however, contains a fair amount of chemicals because of the organic matter present, derived from the litter of forest trees which, through their deep rooting system, penetrate into the lower layers not yet completely sterilized by leaching. It is to be noted also that the top layer is more sandy.

The true significance of the organic carbon content is worth special consideration. Only a small proportion of this organic matter is true humus, namely, that fraction of the organic colloids of the soil which can combine with the minerals in the soil to form the stable organic-mineral aggregates.

The marked acidity of the Basin's soils makes for fungal rather than bacterial decomposition of the organic matter and the predominance of unstable organic mineral complexes.

Lastly, the soil's inability to retain the kaolin clay bases accentuates its poorness for cropping.

Soils similar to the Yangambi type occur over a very considerable part of the Central Basin. Towards the south they are bordered by sandier, acid soils which are similarly infertile. Towards the west and the southwest the soil is more clayey but the ground is usually low-lying marsh. In the north, higher-lying areas of fine sand and more clayey soils are found. Roughly the Yangambi type represents the average fertility of the Basin lands.

The low fertility of the Central Basin contrasts with the luxuriant appearance of the equatorial forest, often wrongly considered as a sign of an inexhaustible soil fertility reserve.[1] Even before any soil analyses were made, disappointing experience showed that this rich plant formation could grow permanently on soil of a very poor chemical composition and only temporary fertility.

Unlike forests in temperate regions, African equatorial forests have practically no ground litter and so there is little accumulation of humus and infiltration. This is due to the rapid destruction of the plant residues through an intense microbial activity consequent on high temperature and constant humidity. Termites also play an important part in the destruction of the dead plant material, so much so that the organic matter content of the forest ground is a bare 1.8 percent.

Clearing the forest to cultivate the land means that a considerable quantity of organic matter is provided to the soil in a short time. Leaves, branches, boughs, fruits, climbers, etc. together with tree trunks and stumps form an inextricable tangle on the ground. Obstruction is so great that it is impossible to start cultivation until this mass of debris has been burned. Otherwise only widely spaced tree crops can be grown.

Burning is necessary for several reasons. First, as pointed out above, it frees the ground of the enormous mass of vegetal trash. In addition, it has the important effect of liberating immediately some of the fertilizer minerals contained in this trash. Also, burning stimulates the action of the soil bacteria which help to produce true humus.

However, the constant humidity, torrential rains, absence of a definite dry season and the intense heat cause the minerals released by burning to be leached out very rapidly, either by runoff or by percolation. Unburned plant residues and the colloidal humus of the soil are, in their turn, very rapidly destroyed by oxidation and especially by microbiological activity. The intense solar radiation on the denuded soil accelerates this oxidation. The peptization of the colloids in the upper soil layers brings about their mobilization and flocculation at a lower level with the formation of a hardpan.

Microbial factors

It has been said that the high acidity of forest land fosters the development of fungi rather than of bacteria. It is chiefly the fungi which, with the termites, destroy the vegetal organic matter as it forms. An acidophilic microfauna, consisting mainly of protozoa, helps to counteract bacterial action. The result is an equilibrium corresponding to the equatorial forest climax, suitable for perennial tree crops, for example, rubber and oil palm plantations, cacao cultivation under forest, etc., but not for annual or, in particular, row crops.

This balance is upset immediately after the clearing and burning of the forest. The effects have not yet been fully studied but it may be taken that the microbial life of the soil increases appreciably as it is stimulated by the release of fertilizer minerals after burning, or by the accumulation of an enormous quantity of plant matter if clearing is not followed by burning. This increase in turn accelerates the decomposition of the raw organic matter and of the humus. The process differs depending on whether or not fire is used. If there is no burning, the acidophilic type microflora increases and, especially if tree crops are grown, the forest-microbial equilibrium of the soil tends gradually to be

[1] Compare: The Amazon Valley, *Unasylva* Vol. VII, No. 3, September 1953.

restored. On the contrary, burning followed by cultivation, especially of row crops, departs from this climax, and the rapid development of the bacteria does not last long. As the organic reserve becomes exhausted, the micro-organisms in the soil very rapidly fall back to a level probably lower than that prevailing in the original forest.

A brief cultivation period has to be followed by a long forest fallow whose purpose is to restore the organic humus reserve and the mineral fertility linked to this reserve by drawing on the deeper layers; to destroy any hardpan that may exist by root penetration; to re-establish the peptization-flocculation balance of the colloids, and the microbial balance in harmony with the climax forest.

As long as the rapid sterilization of the soil can be counteracted only by forest fallow, shifting cultivation will remain an inescapable necessity for the production of annual food and industrial crops.

Biological factors

The adoption of mixed farming, combining cattle-raising with crop growing, might perhaps have enabled primitive peoples to develop a better form of agriculture including the use of organic manure and of draft or pack animals. The prevalence of animal trypanosomiasis throughout the Congo Basin prevented cattle-raising. The tsetse flies found everywhere transmitted the disease. In fact, at the beginning of European penetration, there was not a single head of cattle in the entire region, and the problem of acclimatizing livestock in this area is as yet still far from being solved.

Among the biological factors should also be included human trypanosomiasis and malaria which, being endemic, lower the vitality of the people and often make them unfit to enter upon a more advanced type of agriculture.

Economic and social conditions

The land had no rental or market value and was never the private or exclusive property of any individual. There was no such thing as land ownership. Each cultivator, provided he respected certain customary rules, might clear the forest wherever he wished and grow his temporary crops. The piece of land he abandoned, after he had harvested his crop, returned to the joint ownership of the clan or tribe. However, the individual or his family, in the narrow sense, retained an exclusive right to harvest the fruits of trees that might grow on the fallow, either wild or planted by him, for instance, sago palm and oil palm. This right, however, must not be taken as being synonymous with ownership in the European sense.

In short, therefore, cropland was considered as a never-failing, inexhaustible gift of God. The idea of private ownership of a restricted land area by individuals, in the European sense of the term, did not exist, but communal ownership by the clan and tribe was thoroughly understood and respected.

Shifting cultivation was the logical result of this land system and the economic and social conditions prevailing in the country, just as it was the sole form of rural economy compatible with the various technical factors described previously.

Factors that Justify the Continuance of Shifting Cultivation

The first reaction of European agricultural experts was to condemn the traditional system of agriculture and advocate the application of technical principles suited to European agriculture. The results of this policy were disastrous, as may be amply demonstrated by the very careful research work undertaken at the Yangambi Experiment Station.[2]

The farming method adopted by the Food Crop Division at Yangambi since 1932 was to prepare the site by clearcutting of the forest, eradication of the stumps, complete burning, deep plowing, seeding with a mixture of *Calopogonium* and *Pueraria*, maintenance of the ground cover for a year, deep plowing under of the cover, second plowing, hoeing and raking.

On the ground thus prepared the following crop rotation was practised: paddy the first season, groundnuts the second, and cassava the third. After the cassava was harvested, the *Calopogonium-Pueraria* cover was restored and maintained for a year, and the crop rotation then repeated.

With this system the rice yield on a single area might drop from 2,341 to 565 kilograms per hectare in three years, and the groundnut crop from 1,362 to 191 kilograms per hectare in five crop seasons. As for cassava, the first crop yield per hectare was about 45 tons but the next one only 30 tons.

Such a drastic falling-off in yield is obviously due to the decline in soil fertility but it has not been determined whether the chief cause is the loss in chemical fertility, the lowering of the humus level, deterioration in soil structure or in microbial balance.

Such a decline in yields definitely condemns the intensive forms of agriculture proposed to replace the shifting cultivation system, so long as it is not possible, by means other than forest fallow, to:

1. replenish the reserve chemical fertilizer elements in the soil;
2. maintain the organic matter level;
3. ensure the protection of the soil structure and the microbiological balance.

The rhizosphere of cultivated plants could be replenished with mineral nutrients by the application of chemical fertilizers, although there are many difficulties in the way, chiefly technical but also economic and social. The technical difficulty is that all the fertilizer experiments conducted so far in the forest zone have proved inconclusive, generally uneconomic and sometimes negative. This is due to the rapid leaching out of the soluble elements or the fixing of the phosphates in insoluble form by iron compounds.

The effects of the rapid leaching out of the fertilizer elements could be counteracted in the case of annuals by side dressings during the growing period. This method allows plants which have a sufficiently developed root system to absorb the soluble fertilizers rapidly before they are leached out by the rains. For perennials, the application of top dressings within the reach of the absorbing roots ought to be satisfactory.

[2] Headquarters of a chain of research centers in Africa directed by the Belgian Institut national pour l'étude agronomique du Congo belge (INEAC).

[illegible] vent the fixing of the phosphate fertilizers [illegible] soluble form, methods that reduce the surface of [illegible]ntact between the soil particles and the minerals applied have been suggested. One method particularly highly recommended is the application of fertilizer in the form of briquettes buried in the soil at the level of the absorbing roots. This method, however, has not yet been applied on a large scale. Lastly, the absorbing complex of the soil could be saturated by heavy applications, as is done in other equatorial regions, and for this natural phosphate fertilizer (rock phosphate) would be more satisfactory than soluble fertilizer (superphosphate).

But even if the adaptation of such methods to local conditions made the application of chemical fertilizers feasible, their widespread use would still be prohibitively expensive. The local cultivator chiefly grows food crops of little market value and too bulky for long distance haulage. The industrial crops that he cultivates like cotton and *Urena*, also have a low money value because of the high cost of delivery to the international market. Added to this, there is no domestic production of fertilizers which therefore would have to be imported. The development of nitrogen fertilizer production in the country would be possible under the present electrification plan but no large deposits of potash and phosphate fertilizers have as yet been discovered. Only magnesium could be produced in large quantities from the magnesian waters of certain lakes and rivers.

Lastly, there is the simple-minded and primitive nature of the people, their fatalism and their attachment to ancestral customs. Agricultural knowledge is still extremely elementary. Considerable extension and demonstration work would be needed to make the practice of fertilizer application general. Apparently it would be useless to appeal to the individual native grower, and the only possible way this could be done would be through agricultural co-operatives. Recently a campaign to group cultivators into co-operatives was launched, which may perhaps be a means of promoting the introduction of fertilizers if their use is technically advisable.

The maintaining of the organic matter level in the soil with the corollary retention of the true humus also presents major difficulties. The chief one lies in the rapid destruction of the organic matter and in the short duration of the humus produced by its decomposition.

In this respect, the types of plant organic matter contributed to the soil must be differentiated, since on this depends the rate at which organic matter will be destroyed. Thus it is recognized that, under equatorial conditions, carbohydrates are decomposed in soil within less than three months, celluloses and hemicelluloses in less than six months, while lignin may last for as long as 17 months.

This corroborates the particular value of forest fallow, as it contributes most of the organic matter in the form of lignin. Still, it is difficult to conceive of a system of intensive agriculture suitable for replacing shifting cultivation that provides lignin, although a system could be envisaged in which a long forest fallow would be applied only at very great intervals, alternating with cropping periods comprising several crop rotations like those mentioned above, but with short intervening artificial fallows and possibly application of mineral fertilizers.

All intensive agriculture systems are in fact based either on the use of green manure crops, compost, farm manure or grass leys. Assuming that a satisfactory method of green manuring could be devised, its application to native agriculture would come up against the same difficulties as the use of fertilizers. The native grower has no draft animals or machines to facilitate the planting and plowing under of green manure crops. In addition, with his mentality it would be most difficult to get him to accept a farming method that requires so much labor without any visible benefit. Lastly, because of the low return on his labor, he is already obliged to devote nearly all of his time to his crops. So it would be impossible to add a technique calling for such a heavy labor expenditure as does green manuring without reducing his crop area, and consequently his already small resources.

The only likely way to obtain a fallow that acts as a soil improver would be to find a plant which, while assuring the regeneration of the soil, could also furnish a commercial crop. In this connection, the cultivation of *Abroma augusta* has been recommended and experiments have been made.

Theoretically, compost would provide the perfect solution to the difficulties of maintaining soil fertility. Experiments conducted in the Congo forest zone prove, in fact, that the same piece of land can be cultivated continually without resorting to fallow, provided that large quantities of compost are applied every year. But here again this solution cannot be used on a large scale. In fact, it raises a twofold problem, first, the production of enormous quantities of material for composting, transport to the compost pits and the making of compost involve much manual labor and, second, its haulage and spreading on to the field is also an extremely onerous job. This system is particularly inapplicable because the native grower has no carting facilities, and all his labor is already expended directly in productive work.

The same problem arises with mulching, often recommended for tree plantations. Conserving the fertility of a piece of land by mulching entails disposing of a plot of ground at least equivalent in size to produce the straw. That area in turn threatens to deteriorate rapidly if methods for preserving soil fertility cannot be applied. The result is a vicious circle.

In this respect, it must not be forgotten that the rapid destruction of the organic matter and humus in the equatorial zone make it necessary to have much larger quantities of compost than in the subtropical or temperate zones. The composting of crop residues alone would provide only trifling quantities compared with the needs. A supply of plant material of other origin would be indispensable.

As there are no cattle in the Equatorial Basin, having recourse to farm manure is, for the moment, merely an idea. The native grower owns only a few goats and sheep and their excreta could, at the most, suffice to enrich a garbage compost heap. This would barely be enough to manure a home vegetable plot to raise vegetables for everyday consumption. Farm manure cannot possibly be considered for the much larger areas required to produce food and industrial crops. Therefore, it will only be in a subsequent stage of the development

of agriculture, when cattle have been acclimatized in the equatorial zone, that it will be possible to contemplate the use of farm manure, though again at that stage, the problems of haulage and conservation of the humus in the soil will arise.

Lastly, ley farming or temporary pasture can only be envisaged when the presence of cattle will allow of recourse to the temporary pasture as a means of ameliorating the soil. In the meantime, its technical suitability would still have to be proved. Leys have the advantage over forest fallow of a better action on soil structure. On the other hand, the shorter grass roots provide less minerals to the arable land and its organic matter is destroyed sooner. It may be difficult to return the land to cultivation after a ley. Naturally, from the economic standpoint, it has the great advantage of allowing a profitable utilization of the fallow and it has the advantage over composting and manuring of eliminating haulage and handling of the organic matter.

Conclusion

These conclusions are hardly encouraging. The renewal of the stock of organic matter in equatorial soils, already difficult in itself because of the economic and technical standing of the native grower, and the lack of livestock, is made even more so by the rapidity with which this organic matter is destroyed. Therefore the soil would have to be replenished with humus at a much quicker rate than crop lands in the temperate zones, and very substantial amounts would have to be applied.

In all the fields touched on above, there is huge scope for scientific agricultural research, if it is desired to find farming methods to replace shifting cultivation. Such studies would seek to:

1. work out the agricultural techniques that would save the maximum organic matter in the soil, chiefly by preventing erosion, protecting the soil against excessive aeration, light and heat from the sun: it would be advisable in this respect to adopt a system of unbroken crop rotations and mixed crops, patterned on the native method, together with perennials;
2. work out the simplest, most efficient and cheapest methods to supply the soil with organic matter, other than by the forest fallow;
3. devise farming methods compatible with a low level of humus in the soil without endangering the conservation of the agricultural value of the latter.

It seems that the prerequisite for substantial progress along these lines is the introduction and widespread use of cattle in the rural economy.

With the introduction of cattle, the cultivator would at once attain a higher level of agriculture. He would increase the profit-earning capacity of his land by converting, through the cattle, the poor primary products of his crops into valuable secondary products (meat, skins, dairy products). The cattle would also ensure the economic utilization of the fallows, thus raising the return on the land. In this manner the terrible weakness of the present rural economy would be remedied, and so pave the way for more intensive farming. These prospects, however, lie very far in the future.

The improvement of the shifting cultivation system and the replacing of primitive forms by intensive forms has for the moment to be examined in the light of economic laws. The desired transformation of agriculture is above all a problem of investment. The shifting cultivator starts with nothing, and changing his methods would mean an enormous investment, per unit area, for land improvements such as clearing the ground of stumps, razing of termite hills, irrigation, drainage, laying of roadways, etc.; for buildings such as sheds for produce and silos; for implements, machines and tools, and vehicles for haulage; for cattle and draft or pack animals.

An investment in agriculture can be envisaged only if it will bring about an increased return on the land at least equal to the interest on the capital invested. This is the more true as the cultivator, having no capital, could only invest in agricultural improvements — either individually or co-operatively — through a credit system.

The position is the same in regard to annual production costs. An improvement in agriculture entailing the additional provision of manpower; repayment of buildings and implements; supply of machinery; outlay on chemical fertilizers, insecticides, fungicides, etc., would bring total production cost to an extremely high figure in comparison with the present one. It would only be advisable if the crop return showed a margin of profit higher than that at present. Here, again, it seems that native agriculture cannot bear even a slight increase in production costs.

Yet it should be noted that the weakness of shifting cultivation is, to a certain extent, a guarantee of economic stability. In fact, a system in which production costs are limited to family labor and which provides the family's food, also protects the villager from economic troubles caused by serious fluctuations on the produce and labor market. A more elaborate system of agriculture would be much more vulnerable.

However that may be, intensifying agriculture, which means investing capital and increasing production costs, will only be possible if the agricultural economy has an adequate capacity for absorption of investment. If not, economic measures likely to increase such capacity will have to precede the technical measures and create conditions favorable to their application.

It is always wise to avoid upsetting an agricultural system by the precipitate introduction of concepts too strange to the traditional mode of thinking. This is particularly so in the case of the native land tenure system, especially suited to shifting cultivation. It is difficult to integrate an intensive system of agriculture into this framework straight away. In other words, account has to be taken of the human factor, which can only be modified slowly and gradually.

It is not possible therefore, for the present, to abandon the Bantu shifting cultivation system and to replace it by more intensive farming methods.

Translated from an original French text.

Forest Research and Experiment Institute,

Inauguration of new building marks intensified activity in all

THE new building of the Forest Research and Experiment Institute, situated within the El Pardo forest estate outside Madrid, was formally inaugurated by His Excellency, the Chief of the State, General Franco, on 2 November 1954.

After the building had been blessed by the Bishop of Madrid, the Director-General of Forests and the Director of the Institute, Señor M. Ganuza, conducted General Franco and a group of distinguished visitors on a tour of the various installations, laboratories, mills and workshops. The forest engineer in charge of each section explained the purpose of his work and the principal problems now being studied, a blending of silvicultural research — the growing of the raw material and its technology — and utilization research.

At the end of the visit, General Franco proceeded to the assembly hall for the official inauguration of the Institute. A feature of this hall is the great walnut entrance door and the interior decoration in chestnut. The main staircase is also in walnut and chestnut.

The new Institute with its park and nurseries occupies an area of 24 hectares. The experimental nurseries cover 9 hectares and are used to raise a variety of forest species of conifers and hardwoods, both indigenous and exotic. There is a unique collection of black poplars, including the most choice Spanish, European and American varieties, as well as many selected hybrids for use in various parts of the country. The park constitutes a study arboretum, with a large variety of forest species spread out in small plots.

Vestibule. Staircase in walnut and chestnut. In the background, windows carry forestry motifs.

The Institute is divided into a number of independent sections to cover all aspects and fields of study connected with forest utilization in Spain, soil conservation, and inland fisheries. Each section has its own affiliated field experiment stations and field staff.

The sections as at present constituted include:

1. *Biology of inland fisheries*, with laboratories, workrooms and aquaria for fish acclimatization and pollution testing.

Above. *Timber mechanics section. Packaging test apparatus.*

Left. *Experimental conduit for study of erosion and siltation.*

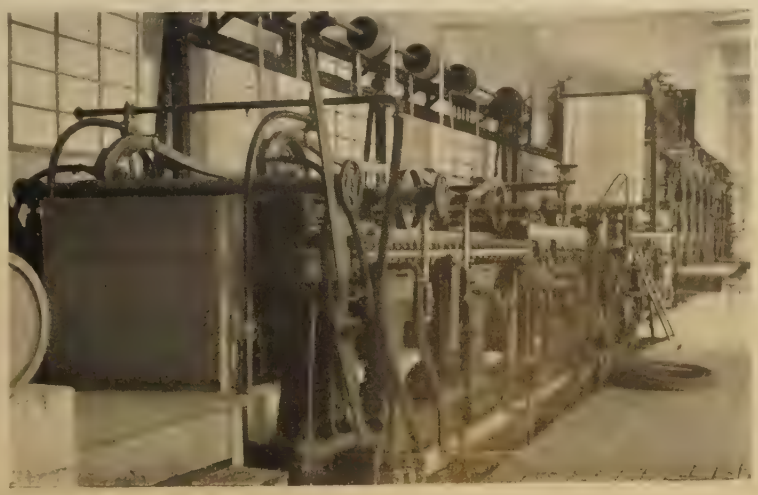
Madrid, Spain

fields of forestry

2. *Pulp*, with experimental paper and rayon machines and laboratories for analysis and physical tests.
3. *Mycology and wood preservation*, with separate laboratories for identification, preparation of culture media and analysis of fungicides, testing of preservatives and of wood impregnation.
4. *Forest flora and dendrology*, with study rooms and herbarium collections.
5. *Torrent control*, with laboratories, conduits and plant for the study, measurement and correction of torrents and soil erosion phenomena.
6. *Timber mechanics*, with the required facilities, laboratories and workshops for the study of timber as building material, seasoning, and testing of all kinds of nailed and glued manufactured products.
7. *Planting and forest genetics*, with workrooms, seed testing laboratories and the nurseries and arboreta required for the cultivation and acclimatization of exotic species and selection of varieties and strains.
8. *Resins*, with an experimental still and chemical and physical laboratories for the study of resinous products and their industrial derivatives.
9. *Forest soils*, with physical and chemical analysis laboratories and facilities for testing fertility and plant growth.

Resins section. Apparatus for experimental distillation.

Pulp and paper section. General view of experimental paper machines.



Translated from an original Spanish text.

Commodity Report

Sawn Softwood

The year 1953 marked a return of stability in world markets for sawn softwood after the excessive short-term fluctuations of the previous years. Conditions tended to continue stable in 1954. In Europe, a further expansion of industrial and building activity led to some increase in the volume of sawn softwood output and trade, while in North America a slowing down of economic activity late in 1953 and early 1954 influenced the demand for sawn softwood and the level of output. Preliminary world figures for 1954 suggest that total production of sawn softwood (excluding the U.S.S.R.) was slightly under 1953, although the aggregate volume of trade probably reached a new high.

Despite certain disturbing factors, market prices also remained, in general, stable in 1954 and the principal markets registered relatively small increases, although in certain countries in Europe domestic prices tended to show disproportionate increases towards the end of the year. It seemed clear that both exporters and importers of sawn softwood were showing a good deal more reason and reserve than had been the case in the 1950 to 1952 period.

A feature of interest in 1954 was the continued progress made by certain traditional importing areas, such as the Pacific region and South Africa, in becoming less dependent on imports from outside. This may mean that the impact of market disturbances and short-term fluctuations in the demand for sawn softwood or else in general economic activities will become more localized and regional in effect. Such a development should logically follow on the present general trend towards more intensive utilization of local timber resources in countries which hitherto have made no substantial use of their forests. The long-term trend for sawn softwood may then be a gradual decline in long-haul shipments between regions contrasting with a bigger volume of trade between countries of one region, except possibly in the case of Europe where the general level and pattern of trade may for some time remain much as it is now.

TABLE 1. – PRODUCTION OF SAWN SOFTWOOD (INCLUDING BOXBOARDS)

Region	1950	1951	1952	1953	1954
	thousands of standards				
North America	*19 356*	*18 907*	*18 653*	*19 400*	*18 496*
United States	15 920	15 250	15 150	15 670	14 960
Canada	3 436	3 657	3 503	3 730	3 536
Europe	*9 440*	*9 380*	*8 550*	*8 760*	*9 080*
Austria	697	694	629	684	804
Belgium	50	51	51	54	54
Denmark	62	60	80	62	60*
Finland	875	1 055	750	870	1 028
France	655	792	578	556	687
Germany, Western	1 709	1 598	1 380	1 275	1 263
Germany, Eastern	(670)	(660)	(650)	(650)	(650)
Greece	20	15	18	21	25
Ireland	3	3	2	2	2*
Italy	222	217	242	227	200*
Luxembourg	3	8	3	6	7
Netherlands	28	28	14	16	14
Norway	358	310	400	375	350
Sweden	1 140	1 300	1 195	1 330	1 [illegible]40*
Switzerland	181	173	197	195	197
United Kingdom	73	65	56	54	62
Yugoslavia	503	363	345	374	287
U.S.S.R.	*(10 000)*	*(11 000)*	*(11 000)*	*(11 640)*	*(12 000)*
Latin America	*600*	*850*	*1 090*	*1 060*	*1 070**
Africa	*190*	*200*	*200*	*210**	*220**
Asia	*2 960*	*3 080*	*3 290*	*3 300*	*3 280**
Pacific Area	*340**	*370*	*400*	*390*	*420**
TOTAL	*42 890*	*43 790*	*43 180*	*44 760*	*44 570*

* Unofficial figure. ( ) Secretariat estimates.
Source: FAO and ECE statistics.

TABLE 2. – WESTERN EUROPE: SOME ECONOMIC INDICATORS

	1952				1953				1954		
	I	II	III	IV	I	II	III	IV	I	II	III
Industrial Production (1950 = 100)	111	110	103	116	113	116	110	125	122	127	121
United Kingdom	106	102	91	105	107	108	99	113	115	116	105
France	117	114	101	113	111	113	95	114	116	123	110
Germany, Western	121	125	126	141	129	137	138	152	143	151	151
Italy	113	116	112	122	119	124	125	138	133	136	137
Dwellings under construction (in thousands)											
United Kingdom	231.7	251.7	276.1	280.3	294.1	314.2	322.1	309.4	307	316	312
France	233.8	248.0	260.3	274.3	284.1	303.6	330.7	351.0	—		
Germany, Western [1]	101.0	130.1	137.0	127.3	92.2	155.2	166.7	155.8	114	161	172

[1] Dwellings authorized. Source: ECE.

REGIONAL ASSESSMENT

Europe

Europe emerged in 1953 from a period of excessive market fluctuations. Demand for sawn softwood began subsequently to rise and become stronger so that the combined production of countries reporting to FAO appeared in 1954 to have approached the high levels of 1950 and 1951.

There was a somewhat higher domestic output of sawn softwood in the principal importing countries than in 1953 but beyond that the volume of trade in fact registered a new post-war high in 1954, due in part to the stimulation caused by the liberalization of softwood consumption controls in the United Kingdom towards the end of 1953. This led to buying being opened unusually early and actively by the British import trade so that in turn by early 1954 the bulk of exportable supplies in Europe had been bespoken. Trade was also made brisker by the general economic development in western Europe, the index of industrial production rising a further 7 percent over 1953. Building construction in particular was maintained at a high level in most western European countries and in some cases reached new records. All these factors combined induced a perhaps unexpected heavy demand by the main importing countries. As it turned out, the United Kingdom only imported for the year some 40,000 standards more than in 1953, but Western Germany and Italy each took almost 100,000 standards more than in the preceding year, and the other main importing countries — Belgium, Denmark, Ireland and the Netherlands — some 130,000 standards more between them.

The main exporting countries in western Europe were under some pressure to provide these supplies, sawmills working for the export trade probably producing close to full capacity. Austrian production of sawn softwood increased substantially, permitting exports 19 percent above those of 1953. But the northern European countries exported more or less at the 1953 level and exports by Yugoslavia fell by some 45,000 standards. Exports by Canada to the United Kingdom showed a fair increase, while the eastern European countries (including the U.S.S.R.) contributed increased supplies to western Europe; their exports have steadily grown in recent years and in 1954 amounted to some 510,000 standards as against, for instance, only 200,000 standards in the boom year of 1951.

Two questions that obviously arise are: what does the 1954 volume of output and trade represent in terms of the actual level of consumption and how does this latter compare with the earlier post-war years? The answer appears to be that in Europe as a whole the level of sawn softwood consumption during 1954 just about reached the average 1946-1951 level, or some 9.4 million standards. This figure is still below the post-war high of 9.6 million standards in 1951. Consumption then had barely regained the earlier levels at a time when the region's total industrial activity was some 45 percent greater than in 1948/49 and the reported building construction was over 50 percent higher. This leads to the conclusion that consumption of sawn softwood has lost ground relatively sharply, and that its position as a raw material has weakened, a trend of which the timber trade is well apprised. Previous reports in *Unasylva* have suggested that it will be difficult for sawn wood, either softwood or hardwood, fully to regain any of the field lost as a result of excessive market fluctuations. Developments in 1954, despite the generally favorable economic conditions in Europe, appear to confirm this.

The position in the European market at the beginning of 1955 was, however, generally considered good. Forward buying for shipment in 1955 was again opened rather early by the United Kingdom, which in the first quarter had already purchased as much as 90 percent of estimated requirements for the year. Most of the other importing countries, too, were well advanced in their buying and the bulk of the year's availabilities in the main exporting countries could be considered as already disposed of. The fact that restrictions placed by the Austrian government on exports of sawn softwood would probably reduce that country's export availabilities by as much as 200,000 standards, compared with the high level of 700,000 standards in 1954, has caused some concern in trade circles as to the possibility

TABLE 3. – TRADE

Region	1951	1952	1953	1954
	Exports			
	thousands of standards			
North America	*2 217*	*2 002*	*1 984*	*(2 352)*
Canada	1 799	1 726	1 745	2 102
United States	418	276	239	250*
Europe	*2 762*	*2 145*	*2 699*	*2 910*
Austria	516	522	594	704
Finland	838	592	675	729
France	185	70	97	101
Sweden	908	696	956	937
Yugoslavia	139	105	152	109
Eastern Europe[1,2]	61	94	143	234
U.S.S.R.[3]	*136*	*129*	*222*	*280*
Latin America	*320*	*240*	*300*	*(280)*
Brazil	233	136	198	180
Africa	*5*	*4*	*5*	*(5)*
Asia	*100*	*25*	*25*	*(20)*
Japan	93	19	21	15*
Pacific Area	*11*	*9*	*10*	*(20)*
New Zealand	11	8	10	16*
TOTAL	*5 550*	*4 550*	*5 240*	*5 870*
	Imports			
	thousands of standards			
North America	*1 184*	*1 200*	*1 332*	*(1 501)*
United States	1 145	1 153	1 287	1 450*
Europe	*2 946*	*2 393*	*2 903*	*3 290*
Belgium-Luxembourg	118	106	104	129
Denmark	163	124	146	174
Germany, Western	172	396	386	490
Italy	198	236	298	387
Netherlands	378	274	332	383
United Kingdom	1 640	981	1 427	1 469
U.S.S.R.[3]	*62*	*123*	*71*	*67*
Latin America	*320*	*310*	*320*	*(300)*
Africa	*350*	*260*	*280*	*(310)*
Egypt	132	60	81	91
French North Africa	66	83	86	90*
Union of South Africa	122	81	83	100*
Asia	*140*	*160*	*200*	*(210)*
Israel	47	34	42	35*
Japan	29	5	27	30*
Turkey	11	36	67	70
Pacific Area	*210*	*140*	*90*	*(130)*
Australia	202	126	79	115*
TOTAL	*5 210*	*4 590*	*5 200*	*5 810*

Bulgaria, Czechoslovakia, Eastern Germany, Poland and Romania.

[1] Importers' figures: exports to countries of western Europe.

[2] Exporters' figures: imports from countries of western Europe.

* Unofficial figure. ( ) Secretariat estimate.

Source: FAO and ECE statistics.

NOTE. — In Table 2, page 76, of the commodity report appearing in *Unasylva* Vol. VIII No. 2, the import figures of the countries listed under *Europe* were inadvertently transposed. They appear in correct sequence in the Table above.

of meeting the rest of the year's requirements, which have not yet nearly been covered, without undue market upsets. There does not seem to be any great chance of the other European exporting countries being able to increase their shipments to the full equivalent of the anticipated reduction in Austria's exports, so that the further course of the sawn softwood market will depend on the nature of the demand actually obtaining later in the year, and on the prospects for receiving larger quantities of sawn softwood from the U.S.S.R., from other eastern European countries, and from overseas.

North America

United States production in 1953 was well maintained throughout the year in response to the high level of industrial and other economic activities, and was only some 1½ percent short of the all time high in 1950. Sizable cuts in United States Government purchases of defence goods, however, and some tapering-off in the demand for producers' and consumers' durable goods brought about a contraction in industrial activity during the first half of 1954, but, at the end of the year, production in most major industries had almost regained the earlier high levels. For the year as a whole, the level of industrial activity was some 6 percent below that in 1953. This decrease was reflected in a fall in output of sawn softwood for the region as a whole from some 19.4 million standards in 1953 to about 18.5 million in 1954, or 5 percent. As compensation for the decline in demand by other industries, construction activity continued high both in the United States and in Canada, so that apparent consumption of sawn softwood only fell by some 3 percent. This involved some drawing on stocks, especially as the sawmill strike in the summer of 1954 reduced the supplies of Douglas fir on the market. Although Canadian exports into the United States rose, stock levels at United States mills were 15 percent below the 1953 fourth quarter at the end of the corresponding period in 1954. In the meantime, from mid-1954 on, production had begun once more to gather pace.

The value of new construction in the United States in 1954 was estimated at a new record of about 37 billion dollars as against 35 billion in 1953, most of the increase taking place in commercial building rather than residential construction.

At the end of 1954, the outlook for the sawn softwood market in North America was one of pronounced optimism. Building activity seemed even to be heading for new records, the temporary slow-down in industrial activity was considered to have been reversed, and a high demand for sawn softwood from all the important quarters, including the individual consumer as the result of the "Do-it-yourself" campaign, was expected in 1955.

Latin America

Some 85 to 90 percent of the total production of sawn softwood in this region is concentrated in Brazil, where the output of Paraná pine has more than doubled since the end of the war. Despite better grading and shipping conditions, exporters have, however, not been able to increase the volume of their shipments corres-

TABLE 4. – NEW AND UNFILLED ORDERS, AND STOCKS, AT UNITED STATES SAWMILLS

	1952		1953		1954			
	I	IV	II	IV	I	II	III	I
	million board feet							
New orders during the quarter								
Douglas fir	2 503	2 491	2 693	2 377	2 709	2 779	1 484	2 581
Southern pine	2 160	2 078	2 251	1 814	2 017	2 320	2 271	2 045
Western pine	1 540	1 943	2 017	1 760	1 646	2 141	2 254	2 178
Orders unfilled at end of quarter								
Douglas fir	961	820	838	750	865	899	778	742
Southern pine	318	295	344	202	257	355	290	239
Western pine	465	628	679	342	418	463	459	439
Stocks at mills at end of quarter								
Total, sawn softwood	—	5 068	—	5 756	—	—	—	5 186
Douglas fir	933	1 043	1 002	987	961	787	774	819
Southern pine	1 610	1 562	1 743	1 976	2 146	2 035	1 770	1 746
Western pine	1 585	1 767	1 557	1 874	1 710	1 696	1 716	1 764

Source: *Survey of Current Business*, United States Department of Commerce.

pondingly; in fact, these have remained more or less unchanged since 1946 except in the general boom year of 1951. This is explained by the heavy increase in domestic demand, and particularly from São Paolo and other big cities. The great economic expansion which has taken place in Brazil during the past years has more than doubled the consumption of sawn softwood in the main industrial centers and has been the main factor encouraging producers to improve their production methods and construct modern mills. The number of sawmills in the main Paraná pine producing states has increased from some 5,600 in 1947 to over 6,900 in 1953.

While the total volume of Brazil's exports of sawn softwood has not changed to any considerable extent, interesting changes have taken place in the destinations of these exports. Argentina, once traditionally the principal customer for Paraná pine, has since 1946/47 taken gradually declining quantities. In 1954, imports were only about one-half of the average 1946/53 shipments. Exports by Brazil to Uruguay have, on the other hand, risen rather steeply and, in 1954, were more than double the average of 1945/48. Exports to the United Kingdom have continued at a fairly high level since 1950, while exports to other markets in 1954 remained at about the previous year's level.

In 1954, however, the Brazilian sawmill industry experienced difficulties as the result of unusually heavy rainfall in the main producing districts. The rate of output was slowed down considerably owing to the difficulty of maintaining supplies of logs, and the poor conditions of roads rendered distribution of sawn wood also difficult, causing temporary shortages in some of the main consumption centers. The rains aggravated the already high cost of handling operations before the wood can reach the shipping point.

Apart from Brazil, the major sawn softwood producing countries are Mexico, Chile, Nicaragua, and Honduras, the first being by far the most important. Pine supplies some 85 percent or close to 300,000 standards of Mexico's recorded total output of sawn wood. Production has not varied very much over the last 14 years, with the exception of a rather steep fall in 1947-1949, caused apparently by reduced building activity. The Government has been greatly concerned to stop excessive exploitation of the country's forest resources and has, since 1952, imposed restrictions on fellings and taxes on sawn wood, resulting in a decline in consumption out of proportion to industrial activity. Despite this, and strong competition from the expanding pulp and paper industry, exports of sawn softwood, principally to the United States, have continued at a relatively high level, including some 47,000 standards to the United States in 1952 and 37,000 standards in 1953. They were probably of the same order in 1954. On the other hand, Mexico imports between 15,000 and 20,000 standards of sawn softwood annually from the United States and these imports seem likely to continue for some time.

Chile has stepped up its sawn wood output in recent years to some 25,000 standards, the increasing production coming mostly from maturing plantations, especially radiata pine. Exports to Argentina have fallen, and probably total exports will decline as internal demand grows. Domestic consumption in Nicaragua and Honduras has been steadily rising but exports, primarily to neighboring countries, have been maintained, the amount for both countries, for all destinations, being some 40,000 standards annually.

The outlook in Latin America for 1955 appears reassuring, especially if better grading practices can be introduced which would greatly help the trade. In the long view, the steadily rising domestic consumption requirements may have to be more widely met by hitherto little used hardwood species which constitute a tremendous reserve for the day when utilization reaches a more advanced stage. The region's softwood resources will probably have to bear an increasing pressure from the pulp industries at the expense of the production of sawn softwood.

In the Near East, the important countries from the point of view of trade are Turkey and Israel which between them have imported some 60,000 to 100,000 standards annually during the past few years. In 1954, Turkey's imports increased slightly.

In Central Asia and the Far East, Japan is the only large-scale producer and consumer of sawn softwood. The considerable expansion of this country's industrial activity, together with pressure of population and housing needs, continue to cause a strain on the national resources, which today can only meet about 60 percent of total Japanese requirements for forest products. Although the output of sawn softwood has been steadily rising since the end of the war, the pulp and paper industry competes strongly with the sawmills and therefore efforts are being made to supplement softwood supplies for sawn wood by hardwood species and by raising imports. Industrialists have been anxious to obtain additional supplies from Alaska and some arrangements to this end have been negotiated.

Sawn softwood consumption in Japan in 1954 was maintained at about the 1953 level. Total construction, including non-residential, showed a slight decline, some 2 ½ percent from the previous year's level, but the number of new dwelling units started remained practically unchanged. There was a decline of 6 percent in the use of wood for dwellings which, although not very important in terms of absolute volume, is indicative of more economical wood-using designs.

In most of the other countries of Asia, the use of sawn softwood is relatively insignificant, requirements generally being met by hardwoods. Indigenous softwood supplies, where available, are more the object of interest by the pulp industries, and sawn softwood requirements have to be covered by imports, which total as much or more than regional softwood production. Owing to reconstruction needs in South Korea, a considerable volume of sawn softwood is being imported although no exact data are available. Supplies come mainly from the United States.

The market position for sawn softwood in Asia in 1955 will probably be much the same as in 1954, depending on the extent to which the pulp industries in Japan will be able to strengthen their position with regard to raw material supplies. Both the Near East and Far East must continue to be softwood deficit areas and for most countries interest must center on the development of the utilization of lesser known hardwoods.

Pacific Area

The market for sawn softwood in Australia in 1952-53 was unusually depressed, imports having been drastically cut after the 1951 boom. In 1952, they were close to one-half only of the preceding year and in 1953 were reduced by some further 40 percent. An interesting feature was the rather remarkable maintenance of imports from North America, while imports from Europe fell from the 1951 high, 86,800 standards, to only 5,300 standards in 1953. At the same time, imports from South America fell from 14,300 standards in 1951 to 5,700 standards in 1953, a relatively smaller decline than in the case of imports from Europe. Imports from New Zealand, the main producing country of the area, were more or less maintained at a level of from 8 to 10,000 standards annually.

Against the trade picture must be set the fact that the regional output of sawn softwood has risen steadily since the end of the war. In 1950, the production of sawn softwood in the whole area was about 340,000 standards; in 1953, it had reached 390,000 standards and, in 1954, has been estimated at some 420,000 standards. This has largely been due to the expansion in New Zealand's timber industries and the growing utilization of the exotic pine resources, notably Radiata pine. But there has also been development of indigenous softwood species, even in New Guinea.

The revival of demand for sawn softwood in Australia and New Zealand from the end of 1953 was largely due to the high level of industrial activity, maintenance of building operations on an almost record level, and general improvement of the economic situation. Exports of sawn softwood to Australia by New Zealand reached a record level in 1954 and were probably close to 16,000 standards. Imports by Australia from other regions were estimated in the same year at close to 100,000 standards, a figure already near to the average volume of imports during the early post-war period. The general stabilization of prices of sawn softwood on international markets after the fluctuations in 1950 to 1952, together with a marked stability in those countries' own general wholesale prices, contributed considerably to the favorable turn of the timber market in 1954.

The outlook at the beginning of 1955 appeared rather satisfactory. The demand for sawn softwood continued at a fairly high level, while construction in both Australia and New Zealand seemed to have good prospects. There seems to be a possibility of imports from overseas showing some further rise in 1955. At the same time, the expansion in the region's own production of sawn softwood can reasonably be expected to continue. The issuing of a first timber trade periodical in New Zealand is indicative of the present promotion drive for sawn wood in the area.

Prices

As described in a previous report (*Unasylva*, Volume VIII, No. 2) prices of sawn softwood fluctuated considerably during the three years preceding 1953. In North America, where overseas trade is marginal and represents only a fraction of the region's total consumption, there were no unduly violent changes (Table 5). In Europe, however, where about 30 percent of the region's total requirements move through international trade, prices are much more sensitive to short-term changes in buying and selling policies.

The general trend in 1954 was some further advance in both international and domestic prices almost everywhere in the world. In North America, the rising demand during the second half of 1954 brought about a clear increase in sawn softwood prices, although not to the level of 1952. In Europe, heavy buying by importers at the end of 1953 led to an increase in export prices and, with the demand continuing strong through 1954, some further advances were registered towards the end of the year. The price level of certain lower quality categories had already been regarded as excessive, and some price adjustment was expected in the

Table 5. – Quarterly Development of Sawn Softwood Prices

	1950	1951	1952		1953		1954				
	IV	IV	I	IV	I	IV	I	II	III	IV	
Sweden, 2 ½ in. × 7 in. u/s redwood battens, f.o.b., Kr. per std.	972 100	1 285 133	1 310 135	1 063 110	1 091 113	1 115 115	1 140 117	1 150 118	1 148 118	1 192 123	1 215 125
Germany, Western, edged spruce-fir boards, 3-4 m. long, 8-18 cm. thick, 21-34 cm. wide, III quality, DM per m³ at sawmill, Bavaria, unloaded.	89.0 100	163.6 184	171.7 193	158.3 178	151.5 170	131.0 152	129.3 146	130.6 147	138.3 155	162.8 183	[illegible] 189
Netherlands, weighted quarterly averages of c.i.f., prices of imported sawn softwood 6 ½ in. 7 in. wide, guilders per std.	742.7 100	1 030.1 139	1 032.5 139	826.8 111	854.1 115	859.9 116	865.3 117	861.5 116	870.4 117	874.6 118	[1] 890.8 120
United Kingdom, price index of imported sawn softwood delivered to consumers (30 June 1949 = 100)	95.1	155.5	168.2	151.5	151.4	138.5	141.7	143.3	145.1	150.0	[2] 153.8
United States of America, Douglas fir, dimension No. 1 common 2 in. × 4 in., RL, U.S. $ per M. bd. ft.	[3] 78.09 100	81.37 104	82.79 106	84.95 109	83.40 107	73.41 94	74.13 95	75.63 97	82.61 106	84.51 108	[1] 83.97 108
Southern pine, boards No. 2 and better, 1 in. × 6 in. RL. U.S. $ per M. bd. ft.	[3] 79.54 100	80.80 102	79.77 100	82.11 103	80.68 102	75.67 95	72.90 92	70.64 89	74.72 94	77.38 97	[1] 78.47 99

[1] Jan. 1955; [2] Jan-Feb. 1955; [3] December 1950 = 100.

Sources: Sweden: *Kommersiella Meddelanden;* Western Germany: *Wirtschaft und Statistik;* United Kingdom: *Board of Trade Journal* Netherlands: figures officially reported to the Secretariat each month; United States of America: *Survey of Current Business.*

course of the spring of 1954. However, the sawmill strike on the Pacific Coast of the United States, which led to increased demand for Canadian sawn wood, brought about a certain rise in Canadian prices for Europe too. As part of the Canadian supplies competes mainly with lower category northern European sawn wood on the European market, this development not only prevented the expected price adjustments but even led to increases.

Towards the end of 1954, the fairly early revival of British forward purchasing activity followed by most of the other importing countries, strengthened prices again, together with the generally rising trend of roundwood stumpage prices in the main European producing countries and the rising c.i.f. quotations of Canadian sawn wood in Europe, owing to higher ocean freight rates. In Western Germany and Austria, the heavy demand during the latter half of 1954 brought about considerable price increases.

Data on price movements in other regions are not readily available. In Brazil, Paraná pine in the main consuming centers fluctuated between a maximum of 2.20 cruzeiros per square foot in 1945 and 1.42 in 1949. From 1950 onwards, however, prices rose steeply and reached 4.40 cruzeiros per square foot in 1954. This development, partly caused by the continuous inflation in the country, was nevertheless primarily a result of the export prices following the trend of European sawn wood prices.

In Mexico, the index of prices for authorized production of sawn pine has shown a steady advance from 100 in 1948 to 184 in 1953. The price of sawn pine in Mexico City advanced from 450 pesos per 1,000 board feet in 1941 to some 1,100 pesos in 1953/54. Internal prices more or less kept pace with the rise in the cost of living in Mexico but have, in general, risen somewhat more slowly than prices of other construction raw materials. Further rises are expected as the result of the increasing cost of labor in logging and manufacture and, as extraction areas become more distant from consumption centers, of the increased cost of distribution and road and rail transport.

The development of prices in Mexico and the reasons influencing it may be considered as fairly typical for most areas where a large scale sawmilling industry is just growing up. As easily accessible resources become temporarily exhausted, logging must extend to more distant forests, often before a transport network has been created. There must, therefore, be increases in the sales prices of the sawn wood. If controlled harvesting is not practised, more areas, due to steadily rising demand, may presently become depleted, and the resulting shortage of sawn wood will have a further effect on price levels.

The Work of FAO

Asia-Pacific Forestry Commission

Tokyo, Japan, was the location for the third session of the FAO Forestry Commission for Asia and the Pacific, held from 9 to 21 April 1955.

In the course of the session, delegates were afforded the opportunity of visiting the site of the Ogochi Dam near Tokyo, which will create a great reservoir to supply the City of Tokyo with water and hydroelectric power. A cableway installation was examined and private forests forming part of a Forest Owners' Association were visited. The management of these forests was explained and discussed.

On other days, delegates visited an exhibition of forest products, logging equipment, wood-working machinery, and prefabricated houses requiring a minimum amount of wood — an important consideration in Japan — and Tokyo University where the facilities for higher forestry education were seen.

Study tour

There was also a four-day study tour to Nagoya and the vicinity, where members visited the Toki erosion control projects in Dachi township, started in 1922 on badly eroded land at the head-waters of a tributary of the Shonai River. Operations have included re-grading, terracing and step-work, afforestation and soil stabilization.

The delegates then visited the Kasugai Mill of the Oji Pulp Company in Kasugai City, and the next day the Kiso National Forest, where unfortunately a landslide caused by heavy rainfall curtailed their stay. On 18 April, the members visited the Port of Nagoya with its timber pools and other installations, and afterwards the Nagoya Plywood Manufacturing Company's mill, which uses both native woods and imported species such as Philippine mahogany.

Opening meeting

Excellent arrangements were made at Tokyo for the business meetings of the Commission, to which the Minister of Agriculture and Forestry welcomed the delegates. The Commission elected Mr. F. R. Amos (Philippines) as its new Chairman. Mr. Thiem Komkris (Thailand) was elected first Vice-Chairman and Mr. S. H. Prakoso (Indonesia) second Vice-Chairman. Mr. G. J. Rodger (Australia) was appointed Rapporteur for the session.

Mr. Sakae Shibata, Director-General, Forestry Agency, Japan, was inducted as Honorary President of the Session. Addressing the Commission, Mr. Shibata stressed that forestry was an integral part of the national economy and the forests were treated as resources to be protected and renewed. Japan had about two-thirds of its land surface under forests but this was insufficient to meet the requirements of the large population and the country was, on balance, an importer of forest products. There was, therefore, a keen interest in the development of the tropical forests of the region. But, in replying, M. Marcel Leloup, Director of the Forestry Division, FAO, warned the meeting against undue optimism about the potentialities of these forests. The discussions at the Fourth World Forestry Congress had shown that many problems must be solved before tropical forests could be brought to anything like full production.

Technical items

The Secretary of the Commission, C. S. Purkayastha (FAO), reported on the work undertaken by the Secretariat on the instructions of the Second Session (Singapore, 1952). The Commission then proceeded to study some of the technical forestry problems of concern to the region as a whole and decided on the priorities for future actions. It asked FAO to accord high priority in its program to the improvement of national statistics, to a technical study on the planning and management of fuelwood plantations, and to compilation of information on timbers useful for housing, following the pattern adopted by the Indian Standards Institute. It decided that a permanent working party on watershed management should be established to facilitate the exchange of information on this subject and encourage co-operation in research work. A training center on watershed management should be arranged. In another field, it recommended that a study of timber trends and prospects in the region be undertaken by FAO in collaboration with ECAFE.

The Commission issued directives to its working party on public education in forestry and to the groups dealing with standard nomenclature of trade timbers, grading of hardwood logs, and grading of sawn hardwoods. Final drafts of standard grading rules were to be submitted to the next session. FAO was asked to establish a regional inventory center, first to help countries in getting available aerial photographs interpreted, and then gradually to be developed into a research and training center in aerial survey techniques.

Approval was given to the procedures under which the new Teak Sub-Commission would operate. The Commission appointed the Inspector-General of Forests, India, as the independent Chairman of this sub-commission and accepted an invitation from Thailand to hold the first session at Bangkok in early 1956.

An important decision of the Commission was that the Director-General should establish two separate and independent regional research committees, one to co-ordinate silvicultural and forest management research (chairman to be nominated by India and rapporteur by Japan), and the other to deal with forest products research (chairman to be nominated by Australia and rapporteur by Malaya). The terms of reference of these committees were laid down. Meetings would be held in the course of regular sessions of the Commission. The next such session would be held in Bandung early in 1957, the Commission having accepted with great appreciation an invitation tendered on behalf of his Government by the delegate of Indonesia.

Progress in forestry

Considerable discussion was devoted to the technical assistance activities of FAO in the region, and also to the progress reports on national forest policy submitted by Member Governments. Many points of interest were raised.

The delegate of Indonesia illustrated the forestry problems arising on the island of Java from population pressure and reported a proposed solution through transplantation of part of the population to other underpopulated islands, intensified agriculture and stock breeding, and industrialization; and not through converting forest lands into other forms of land use.

A delegate of the United Kingdom explained the efforts made in Hong Kong to solve problems of water shortage and of supplies of cheap fuelwood, caused by an enormous increase in population. The Philippines' delegate described attempts made to enlist the co-operation of the entire population, from village to national level, in maintaining a forest cover of 42 percent of the total land surface in his country.

Fifty-eight representatives from seventeen member countries participated in the session: Australia, Burma, Cambodia, Ceylon, France, India, Indonesia, Japan, Korea, Laos, Netherlands, Philippines, Portugal, Thailand, United Kingdom (Federation of Malaya, Singapore, Sarawak and Hong Kong), United States of America, and Viet-Nam. The Union of Soviet Socialist Republics was represented by an observer, as were the Holy See, United Nations (ECAFE), and the World Meteorological Organization (WMO).

The Llancacura Forest Research and Training Center

A co-operative project of FAO with the Government of Chile

On 11 February 1955 Señor Enrique Casas, Minister of Lands and Colonization, pulled a switch that started the motors for head saws in the modern sawmill at Llancacura. This marked the official inauguration of the Center[1], the most ambitious FAO forestry project in Chile.

The widespread interest in the center and appreciation of its value to Chile was evident from the large attendance and the expressions of approval from those who participated. The 140 guests included three Ministers of State, those for Lands and Colonization, for Agriculture and for the Interior, the Director of Forests and other government officials, Rectors of the University of Chile and University of the South at Valdivia and other educators, officials of the provinces of Valdivia and Osorno and many lumber men and timber owners.

These guests inspected the sawmill, power house and other buildings and equipment, lumber piling, operation of the charcoal kilns, the forest nursery and a demonstration of road building by large tractor-bulldozer. Time did not permit a general inspection of the forest operations, but a group of fifty people were taken by truck to the landing where loading of logs was in progress.

Llancacura Forest Reserve

The selection of this reserve for the center was made only after a careful study of all the possible alternative sites. It was recognized that lack of access except by water, and the limited forest area, were disadvantages. These shortcomings could, however, be remedied if funds were provided commensurate with the value of the center to the future of forestry in Chile. Advantages of the area were year-long accessibility by river, an excellent site for the sawmill, and a wide range of topographic and forest type and stand conditions, representative of the commercial native forests of Southern Chile.

The Llancacura reserve, with an area of some 4,600 hectares, is located in Valdivia Province, immediately north of the Río Bueno, one of the finest rivers of Chile. Access at present is by motor launch or river steamer from Trumao, a railhead 30 kilometers northeast of Osorno. But construction of a three kilometer roadlink will permit truck transport directly to railroad at La Unión, 32 kilometers distant.

Topography and climate

In common with other forested areas in this region, the topography is moderate to very steep. Slopes rise sharply, either directly from the river or from narrow bordering flats, most of which are flooded during periods of high water. Small streams of steep gradient are common, in addition to the two main drainages, one on the west boundary, the other on the east of the reserve. The southern part of the reserve has been partially cleared by settlers (*coloños*) but still contains a considerable area of forest. A number of ox-team roads provide access to the *hijuelas* (clearings).

The northern half of the reserve, starting about five kilometers back from the river, is largely occupied by a well-forested, flat-topped ridge with moderate gradient upward to the northwest. Elevations on the ridge are mainly from 450 to 600 meters with a few higher points.

The combined effect of latitude (S 40° 15') and coastal influence result in a climate at Llancacura similar to that of the coastal region of the State of Washington in the United States and British Columbia in Canada. The temperature range is moderate, with no extreme of either heat or cold. Freezing temperatures occur only occasionally and are of short duration.

Total annual rainfall is heavy (about 2,500 millimeters) and, though heaviest in the winter months of May to September, is usually adequate throughout the year. Almost continuous rainfall for extended periods during the wet season makes logging difficult, so that for year-long operation of the sawmill storage of logs at the mill and along all-weather roads will be necessary.

Forest conditions

The original area of the reserve was 3,700 hectares to which has been added another unit of 900 hectares, making a total of 4,600 hectares. The undisturbed forest of the reserve includes one of the best stands of natural forest remaining in the coastal range between the rivers Valdivia and Bueno. It is composed principally of hardwoods characteristic of this region, with coigüe (*Nothofagus dombeyi*), ulmo (*Eucryphia cordifolia*), tineo (*Weinmannia trichosperma*), tepa (*Laurelia serrata*), and olivillo (*Aextoxicon punctatum*) forming about 75 percent of the timber volume. Other important species limited to particular localities, governed by site and elevation, are roble (*Nothofagus obliqua*), laurel (*Laurelia sempervivens*) and lingue (*Persea lingue*), which occur at elevations below 600 meters, and raulí (*Nothofagus procera*) above this elevation. Trevo (*Flotowia diacanthoides*) is quite common but generally of poor quality, while canelo (*Trimys winteri*), luma (*Myrtus luma*) and avellano (*Guevina avelland*) are common in the understory, occasionally occurring also as subdominants.

Four coniferous species are found but, with the exception of a limited area of merchantable alerce (*Fitzroya cupressoides*), they occur mainly as reproduction or small trees, scattered singly or in patches in the understory. Of these, manio macho (*Saxegothea conspicua*) and manio hembra (*Podocarpus nubigenus*) are more common at the higher elevations, and manio (*Podocarpus salignus*) at the lower.

The volume of commercial timber, of all species, according to preliminary estimates is about 189,000 cubic meters, the potential annual yield between 3,500 and 4,700 cubic meters. This volume is insufficient to justify a sawmill of the size provided, about 60 cubic meters of daily capacity, if considered purely from the viewpoint of a private operator. But it is adequate to provide the material needed to carry out the purposes of the center — research, demonstration and training. In addition, the available timber can be supplemented by purchase of logs delivered via the Río Bueno, or adjacent forest properties can be acquired.

Equipment and facilities

Plans for the center provide for a fully equipped logging and milling operation with modern equipment considered economically practical for exploitation of commercial forests of southern Chile. Present facilities include a modern, fully equipped sawmill, a limited amount of logging and log transport equipment, portable steel charcoal kilns, office, shop, storage and garage buildings, a limited amount of housing for workers, a water system and about 8 kilometers of truck roads, most of which will need surfacing for all-weather use.

The mill was designed not only to demonstrate efficient lumber production but also to permit independent operation and comparative tests for three types of sawmills. Thus logs may be delivered directly to the double circular head saw, to the band mill or to the Scandinavian table/circular saw. In normal operation, however, cants for the bandsaw will be produced by the circular mill and transferred by a conveyor system to the bandsaw. Heavy slabs and unedged planks are transferred

[1] The FAO Director of the Center is Hubert L. Person (U.S.A.) and the Chilean Administrator is Constantino Cholaky. Other members of the FAO Technical Assistance Mission under its chief, E. I. Kotok now retired, have all contributed a share, particularly L. Hartman (Finland), in the design, construction and initial operation of the sawmill.

to the [illegible] saw for resawing. [illegible] less than 6.4 centimeters [illegible] will be edged by the [illegible]n edger. All slabs and [illegible] suitable for lumber are [illegible]rted by conveyors to the short [illegible]nsion stock section at the rear [illegible] the mill. Material unsuitable for short dimension stock is transported to the yard by means of carts on rails for conversion into charcoal.

An important feature of the mill is the sorting table with powered conveyor and the facilities for segregating and transporting lumber to the drying yard by means of lumber carts on rails moved by gravity.

All purchases of equipment were made through FAO, with consideration given both to the recommendations of the Forestry Mission in Chile and the currencies for expenditure available to the Organization.

Present equipment includes the following items:

1. North American *circular headsaw*, equipped with top saw rig, log turner, power receeder for headblocks, horizontal lumber scale and sawdust drag;
2. Belgian *log band saw* (size 1.4 meter) with automatic and manual dividing apparatus;
3. Scandinavian *light circular saw* (ordinary type);
4. North American *2-saw edger*;
5. 15-meter *sorting table* with powered 3-chain conveyor and trim saws (from Sweden);
6. *cross chain conveyor* from circular saw to band saw (from Sweden);
7. *roller conveyor* from band saw to sorting table (from Sweden).

In addition, the following machines were bought for the short dimension stock department:

1. swing *cut off saw* (Germany);
2. Swedish mechanized *circular resaw* for sawing short pieces;
3. German circular *edger* for edging short pieces;
4. simple "travelling table" *cross-cut saw* (Sweden).

For the maintenance of sawblades, very complete tools and machinery were purchased, including the following main items:

1. complete *filing and maintenance equipment for the log band saw* (Belgium);
2. *automatic filing machine* for circular saws (Germany);
3. *hand operated filing machine* for circular saws (Sweden);
4. five sets of tools for hammering circular saws (anvil blocks, straight edges, hammers) and different types of swaging and brazing (soldering) apparatus, etc.;
5. *air collector* from Sweden for removal of sawdust from all machines except the American circular saw, which is equipped with a sawdust drag, as mentioned above;
6. in order to move logs to the main logdecks from the principal log yard on rails, a specially constructed *log wagon*, Decauville, (Sweden);
7. twenty *lumber yard wagons*, all equipped with ball bearings (Sweden);
8. after studying the question of the most suitable power unit, two *85 Kw diesel generating units*: these were found to be more economical than a steam power unit and, in view of the rather short sawing season, the operating cost was cheaper also (Italy).

The construction of the sawmill was begun at Llancacura early in 1953 and was completed in December of that year but the first lumber was not cut until near the end of June 1954, because of delays in the delivery of the diesel power units.

Log production and transport

The main body of timber is located on a ridge at an elevation of 450 to 600 meters. A truck road of 7 kilometers has been constructed to this forest where exploitation is now in progress.

Felling and bucking will be done largely with cross-cut saws, but supplemented with gasoline motor-driven chain saws. Four chain saws, supplied without cost by Australia, will be used to determine the practicability of felling and bucking with power saws and efficiency in comparison with hand tools. The four saws include a small one-man saw with 24 inch (60 cm.) blade, two with 48 inch (120 cm.) blades and one with 60 inch (150 cm.).

It is planned to keep skidding distances for logs to a minimum and to yard to truck loading points, both with oxen and tractor. Two English diesel tractors with caterpillar tread — one of about 35 h.p. and the other 82 h.p. at drawbar are available. Both units are equipped with winches and will be used to provide a comparison with oxen for ground skidding and bunching. A complete tractor-arch unit will be added to this equipment, particularly for long distance skidding, when funds are available. Delivery of a logging pan with chokers and other rigging is expected in 1955.

The large tractor is equipped with a hydraulically operated angle-dozer which has proved invaluable for the construction of roads at low cost.

Logs will be transported from woods to mill by truck, supplemented by wheel tractors with log wagons. One 8-ton platform truck was put into service at the center in December 1954 and a semi-trailer truck has been shipped — both from the United States.

Two diesel wheel-tractors of British manufacture were received early in the development of the center and have been very useful for general transport of equipment, material and personnel.

FIGURE 1. *Logs being unloaded directly to the sawmill log deck from an 8-ton truck.*

Research and training

Llancacura is a training center, not a business enterprise. Although production must be sufficient to allow determining costs and returns applicable to private forest industries,

high production and profits will be subordinated to the more important research and training functions of the center.

Research is needed to determine the most efficient and practical equipment and methods applicable to the native southern forests. This is necessary as a basis for a sound training program. This research program will include:

1. *Management and silvicultural studies*

   To determine the most economical means of converting the natural, largely overmature forests to a fully productive managed forest; most important will be methods of cutting and natural regeneration studies.

2. *Restoration of cut-over lands*

   (*a*) Restoration of cut-over stands with some established regeneration. There is a large acreage of cut-over land on sites unsuitable for agriculture that have not been repeatedly re-burned and which have some regrowth, both sprout and seedling, of the better species such as lingue, roble, rauli and avellano. Sample areas will be established and protected from fire and livestock to determine the rate of recovery and growth under different cultural treatments, such as:

   (*i*) thinning and pruning of clumps,

   (*ii*) control of competing vegetation where necessary to prevent suppression,

   (*iii*) interplanting where necessary to obtain fully stocked stands — both with native species and with such exotics as Radiata pine, Douglas fir and Port Orford cedar.

   (*b*) Plantations. In addition to the above interplanting, experimental plantations of several of the most promising exotic species will be established and staked to permit the study of survival and growth under different slope gradient and exposure, site and competitive conditions.

3. *Logging studies*

   (*a*) Cost comparison studies of oxen and tractors.

   (*b*) Log length studies to determine effect on volume and log quality and logging and transport costs;

   (*c*) Felling and bucking costs for hand-saws and chain-saws.

FIGURE 2. *View of the well-equipped saw maintenance room. Automatic machine at left sharpens band saw while the "saw doctor" (center) and his assistant condition circular saws.*

4. *Sawmilling*

   (*a*) Comparative efficiency of double circular and band headsaws.

   (*b*) Air seasoning studies — piling methods, effect on rates of drying and degrade.

   (*c*) Lumber grading studies.

5. *Marketing studies*

   Preliminary surveys of marketability of various sizes and grades of lumber of the species available at Llancacura are needed as a guide to cutting and utilization practices at the center.

The most important single objective of the center is to provide facilities for training foremen, technicians, and forest engineers. This training should include wood and mill practices and techniques that will insure the continuous productivity of forest lands and the most efficient production and utilization of timber products. The program will cover training for three distinct groups — forestry students at the professional level, technical students and specialized workers and foremen from forest industries. For students from the School of Forestry, University of Chile (see *Unasylva* Vol. VII, No. 3) a ten-week summer school course was held in 1953 and 1954, and will be continued as a regular part of the course for the forest engineers. This course is integrated with the regular courses given at Santiago to provide practical training in the forest in silviculture, forest management and protection, mensuration and forest engineering, and logging and milling practices. Teaching at the professional level will be expanded as needed to take care of students from other universities, as at Concepción and Valdivia.

Training was given in 1954 to forestry students from Temuco Technical School in sawmill and logging equipment operation and maintenance, in road location and construction, timber cruising, log scaling and forest fire suppression. This training will continue to be organized in co-operation with the Temuco school and other technical institutions that wish to co-operate.

High priority will be given in the future to organizing courses of special value to selected workers and foremen and technicians now privately employed in the forest industries. Training will be developed in co-operation with the lumber industry to cover subjects in such fields as management and cutting practices, variable log lengths, logging methods, sawmill operation and maintenance, saw maintenance, grading, piling and seasoning. The value of this training will increase as the comparative efficiency of different equipment and operating practices is determined by research.

Future possibilities

The Llancacura Forest Center offers exceptional opportunities and there are actually few, if any, such centers elsewhere in the world that can equal it in equipment and the other facilities necessary for the determination and demonstration of the most effective methods of forest management and exploitation.

The contribution that it makes to forest practices in Chile will depend largely on the support that it obtains from the forest industries themselves. But in spite of many disappointments and difficulties, FAO and the *Dirección de Bosques* have developed the center to the point where it can now begin to fulfill its purpose, and are confident that it will receive co-operation and support.

Equipment News

Interest in the development of forest utilization and woodworking industries is reflected in the continual demand for information on new equipment. The Forestry Division, FAO, collects such information and passes it, on request, to Member Governments: a selection is published here. FAO accepts no responsibility for the claims of manufacturers.

CONICAL POST POINTER. — This apparatus is a cheap and simple construction for sharpening posts. It consists of a metal conical body with a 12 in. (30.5 cm.) blade, 2 in. (5 cm). wide and ¼ in. (0.6 cm.) thick.

Inventor: Mr. E. Salthouse, 25 Westbourne Road, Urmston, Manchester, England.

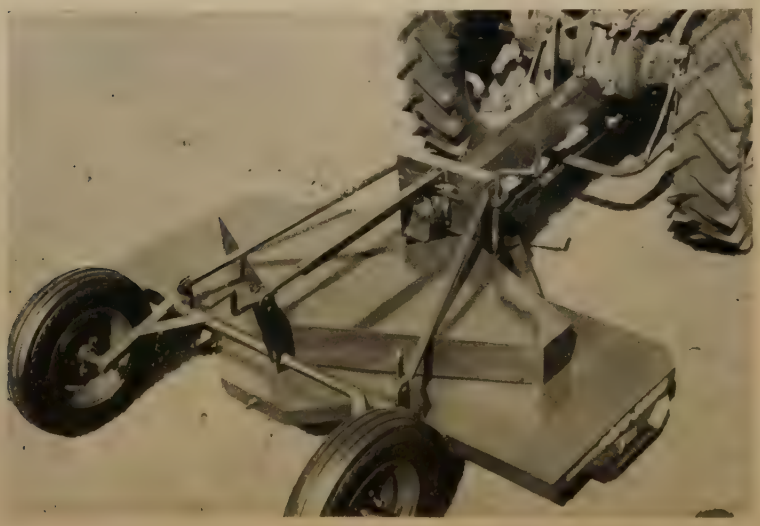
CAGE WHEELS. — The single cage wheel prevents soil consolidation caused by the tractor wheel. It can be bolted to the side of the tractor wheel and the diameter is designed to allow the cage wheel and tyre to take the weight of the tractor, while keeping the pneumatic wheel from panning into the land. The double cage wheels illustrated here completely replace tractor wheels and are well suited to bog and swamp land.

Catchpole Engineering Co. Ltd., 19, Hatter Street, Bury St. Edmunds, Suffolk, England.

ROTO-SPEED. — This machine cuts brush, briars, vines and other undergrowth up to 2 in. (5 cm.) diameter; it eliminates raking and burning and can be used for reducing fire hazard. It has three pairs of rotary blades.

Specifications: cutting width 7 ft. 6 in. (2.3 m.); over-all width 8 ft. ½ in. (2.5 m.); over-all length 8 ft. 2 in. (2.5 m.); maximum cutting height 14 in. (35.6 cm.); minimum cutting height 2 in. (5 cm.); operating speed 3.5 to 7 m.p.h. (5.6 to 11.2 km.); weight 915 lb. (415 kg.).

Lilliston Equipment Co., Albany, Georgia, U.S.A.

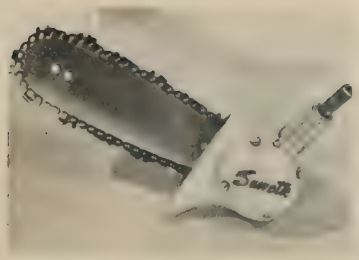


BRUSH CUTTING CHAIN SAW ATTACHMENT. — This attachment is designed for Standard Lombard chain saw models 30, 35, 3A or 3-1/2D. It is interchangeable with the chain saw blade and can be fixed quickly and easily to the motor.

Lombard Governor Corp., Ashland, Massachusetts, U.S.A.

GASOLINE WRIGHT SAW. — This saw with its reciprocating action is based on the same principle as the hand saw, and cuts at a speed of 160 strokes per second. It is designed for felling, limbing and bucking trees up to 30 in. (76 cm.) diameter. An automatic cut-off stops the saw as soon as the trigger is released. The saw is powered by a twin cylinder, single firing gasoline engine. The blades are permanently set and may be sharpened with an ordinary flat file, and the job requires no special equipment or tools. Weight of saw, 25 lb. (11 kg.).

Wright Power Saw and Tool Corp., 292 Longbrook Ave., Stratford, Connecticut, U.S.A.



THE SAWETTE. — A chain saw cutting trees of any growth up to 6 in. (15 cm.) diameter. Power is provided by a 2 h.p. engine turning at 4,000 r.p.m. transmitted by automatic centrifugal clutch. One piece crank case cylinder is equipped with air cleaner and push-button dump valve and air vane which automatically adjusts engine speed to fit load requirements. Can be equipped with the Scythette to cut weeds and reeds.

Hoffco, Inc., Richmond, Indiana, U.S.A.

ROUND SPOUT CORE CHIPPER This machine utilizes entire knife area, permitting maximum diameter stock for reduction into uniform chips. The spout opening is dependent upon the disc diameter and the number of knives depends upon the required production rate. The Chipper has a 21 in. (53 cm.) spout opening with a 78 in. (198 cm.) disc; three knives can handle the production adequately with minimum horsepower requirements.

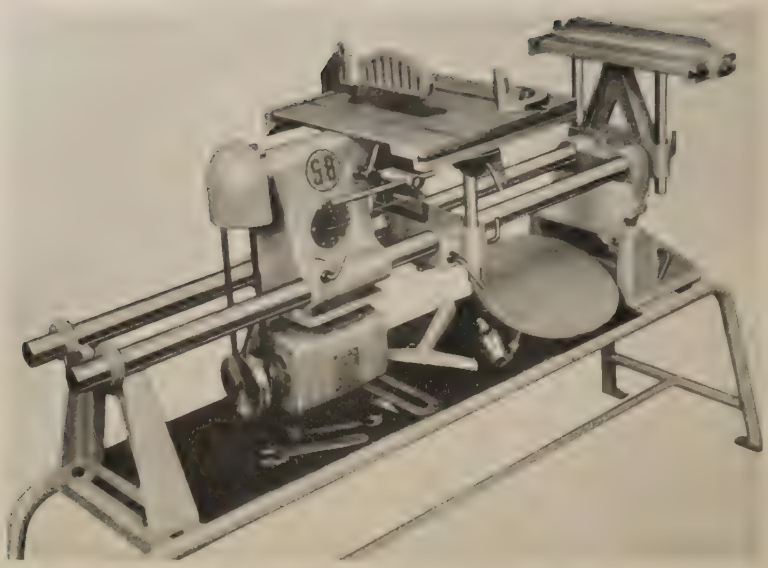
Sumner Iron Works, Everett, Washington, U.S.A.

THE "NORTHGATE" WOOD CHOPPER. — This machine is designed to convert tree tops, small branches, brushwood, etc., into logs and kindling wood of 6 in. (15 cm.) lengths, handling material up to a maximum of 3 ½ in. to 4 ½ in. (8.9 to 11.4 cm.) diameter. The chopping agent is a very heavy steel knife which is carried along with four steel angle beaters on a counter-balanced cast iron wheel. The wood chopper may be driven from the power take-off of a tractor through a countershaft to avoid transmission of vibration etc., or alternatively and preferably by its own self-contained power unit.

Sole Distributors: Gopsill Brown Trading Co. Ltd., Severn Road, Gloucester, England.

SCAMMEL 6 × 6 "CONSTRUCTOR" This range of vehicles has been designed for heavy duty under "off-the-road" conditions, and can be equipped with an extensible pole type semi-trailer for round timber haulage. With the Scammel automatic coupling a tractor may be coupled to a trailer at any angle up to 90° and the operation of either coupling or uncoupling is under the control of the driver who need not leave the cab during the operation. *Specifications:* motor, Rolls-Royce 185 b.h.p. diesel; gearbox, 6 speeds with 2-speed transposing box giving 12 speeds forward and 2 reverse; driving axles, 3 epicyclic. Maximum tractive effort 45,000 lb. (20,400 kg.); available wheelbases, 15 ft. 9 in. (4.8 m.), 17 ft. 8 in. (5.2 m.) and 21 ft. 9 in. (6.6 m.).

Scammel Lorries Ltd., Watford, Hertfordshire, England.



THE VERSATOOL. — Comprises a disc sander, vertical and horizontal drilling machine, circular saw (as illustrated), and wood-turning lathe. All attachments are secured to spindle nose by a locking screw. Drive by means of ½ h.p., 1,400 r.p.m. motor. Table tilt — any angle through 90° in one direction and 45° in the other. *Specifications: disc sander* — diameter of sanding disc, 12 in. (30.5 cm.). *Vertical and horizontal drilling machine* — capacity of drill chuck, 0 to ½ in. (1.3 cm.); spindle speeds, 3,400, 2,400, 1,700, 1,200, 900 and 600 r.p.m. *Circular saw* — diameter of saw, 8 in. (20 cm.). *Wood turning lathe* — maximum swing, 15 in. (38 cm.).

Smart and Brown (Machine Tools) Ltd., 25 Manchester Square, London, W. 1., England.

LOADER CRANE. - This machine is designed to speed up operations in moving pulpwood in the storage yard. The loader is mounted on a Case "LAI" industrial tractor. Equipped with automatic counter-weight which moves back as load is raised transmitting stress to back axle, thereby reducing strain caused by "rocking". Bulldozer and other attachments can be operated by this unit. *Specifications*: weight of loader and tractor, including counter-weight, 23,700 lb. (10,980 kg.); weight of tractor only, 7,200 lb. (3,270 kg.); engine, 4-cylinder, brake horsepower 61 at 1,100 r.p.m.; governed speed under load 1,100 r.p.m. Turning radius, 16 ft. 3 in. (5 m.).

Harrison Manufacturing Co., Columbia, South Carolina, U.S.A.

COMBINED BAND PUSH BENCH. — Convertible band push bench to break down round logs of medium size. The fixed table converts to hand-feed resaw. *Specifications:* maximum depth of cut, 2 ft. 8 in. (0.81 m.); speed, 650 r.p.m.; motor, 25 b.h.p.; size of fast and loose pulleys, 18 in. × 6 in. (46 × 15 cm.). Size of table: rolling table, 10 ft. × 20 in. × 10 in. (3 m. × 51 cm. × 26 cm.); fixed table, 3 ft. 9 in. × 2 ft. 4 ½ in. (1.1 × 0.7 m.). Table height: rolling table, 3 ft. 9 in. (1.1 m.); fixed table, 2 ft. 9 in. (0.84 m.).

Stenners of Tiverton Ltd., Lowman Works, Tiverton, Devon, England.

News of the World

The items appearing here are condensed from newsworthy material collected by FAO staff or submitted by correspondents. FAO assumes no responsibility for statements and statistics in items accepted in good faith from contributors.

Afghanistan

• Afghan economy is very dependent on the export of Karakul lambskins, which together with wool bring in almost 50 percent of the foreign exchange. Afghan skins, both grey and black, are perhaps as high in quality as any in the world, most being marketed as "Persian lamb". As a rule, only ram lambs are pelted. All but the very poor quality ewe lambs are kept for breeding.

Afghanistan is a mountainous country, having large expanses of desert and steppe. The Karakul sheep flocks are located almost entirely north of the Hindu Kush range of mountains where spring range conditions are invariably good and summer range conditions also favorable. The greatest sheep losses are due to lack of winter pasture and of supplemental feed during the severe period from January to March. An FAO Technical Assistance officer has devised ways of collecting for winter use the many hundreds of tons of camel thorn and grasses left ungrazed on the spring and summer pastures. He has also laid out experimental plots of 15 varieties of grasses which may prove to be adaptable to the northern steppe region of the country, and might then be used for general range reseeding.

Australia

• A recent *Forest Products Newsletter* of the Commonwealth Scientific and Industrial Research Organization points out that resources available today do not allow production to be restricted to timber free from every real or imaginary blemish. The sawmiller has to ensure the maximum yield of industrially usable timber, sort it with regard to the requirements for different purposes, and offer it for sale in the respective qualities in the proportions in which these can be produced. While customers ask only for faultless timber, irrespective of service requirements, the demand for this sort of timber will quickly overtake supply and the disposal of other sorts will be hindered. It is necessary for the consumer as well as the sawmiller to recognize that certain characteristics in mill run timber are not detrimental in certain uses.

Timber is graded from considerations of either appearance or strength.

The appearance is most important in furniture, fittings, moldings, floors, doors, windows, and other items which are on display. Even in these uses, however, all timber is not finished with a clear coating. Some furniture, moldings, doors, etc., are painted. Large areas of floors are covered with linoleum or carpet and in other circumstances other opaque coverings may be applied. It is wasteful to meet the cost of eliminating minor blemishes which may detract from the appearance of timber finished in the clear and then utilize that timber under some screening material. It would be more economical to estimate what pieces or areas are to be finished in the clear, what are to have some covering, and then to order requirements accordingly. If the supplier knows these requirements, he can make available for covered use material containing imperfections which will not lower the quality of the finished job any more than an imperfection permissible in the highest grade will detrimentally affect the clear finish. A dissection of the order in this way can assist the production of both grades, expedite delivery, and effect economy. For these reasons the sawmilling industry offers dressing quality timber in select grade suitable for clear finishing and standard grade suitable for covering.

When strength is the basis of grading, appearance is of minor importance. A timber component for a structural frame with appearance marred by small defects, which do not reduce its strength or the resistance to deflection, will be just as suitable for that use as a piece in absolutely unblemished condition. Supply of the latter for framework only reduces the quantity available for the furniture or joinery trade and prevents scarce material from being used to advantage.

Burma

• The *Burmese Forester* reports that on 27 June 1954 Burma for the first time celebrated a "World Festival of Trees" day. Saplings and seeds of various species, ranging from flowering shrubs to trees of commercial value, were planted throughout the country to mark the occasion, which was sponsored by the Agricultural and Rural Development Corporation. At Rangoon, the ceremony opened early in the morning with recitations from the Buddhist Scriptures, followed by speeches by the Prime Minister and high-ranking civil and military officials, and then by the planting of trees. A large gathering of people attended.

Canada

• An economic survey, carried out on farm woodlots in the Province of Ontario, covered 162 farms averaging 242 acres (97 ha.) a considerably larger size than the average Ontario farm. It is computed that, on each farm, an average of 30 percent or 29 hectares consists of woodland, in which maples are generally well represented. The average capital investment per farm is $ 22,974 and the average woodlot is valued at $ 1,437 or 6 percent. The average annual cash income derived from a woodlot, taking into account both the products used on the farm and those sold outside, is estimated at $ 500, of which lumber accounts for 40 percent, maple syrup 13 percent, and fuelwood, poles, posts, etc. for the rest. This income represents 4 percent of the total farm income.

Providing employment particularly during agricultural off-seasons, labor is the largest single item of expense in woodland operations, involving on an average 294 hours of labor annually (excluding the harvesting of maple syrup). Most products are sold on an "at the farm" basis. However, a fairly large proportion of timber *is* sold on a "delivered at the mill" basis, although some farmers sell only on the stump.

For the five-year period from 1946-1950 the average cut was 27 cubic feet of wood per acre (2 m^3 per ha.) annually. This compares with an estimate by the Ontario Royal Commission on Forestry, reporting in 1947 on farm woodlots, that if sound silvicultural methods were employed, a sustained yield of 36 cubic feet (2.7 m^3 per ha.) could be obtained at 30 years of age, rising to 48 cubic feet (3.6 m^3 per ha.) at about 75 years.

The survey brings out the interesting point that more than half the farm woodlots investigated were grazed, at least partially. The average annual timber income was $ 10.20 per acre ($ 25 per ha.) from ungrazed woodlots, and only $ 5.62 per acre ($ 14 per ha.) from grazed forests. It should be noted, however, that the farms in question get most of their income from livestock production, the returns from this source, including the sale of dairy products, representing on an average 85 percent of total income.

• A study of an unexploited forest of white spruce (*Picea glauca*) and balsam fir (*Abies balsamea*) in Ontario, issued by the Division of Forest Biology of the Department of Agriculture, indicated that the current

outbreak of spruce budworm, which has now lasted for about ten years, is a recurrence of a similar outbreak of about 85 years ago. It is known that mature or flowering balsam fir provide conditions favorable to increasing populations of the budworm, and thus to the initiation and spread of epidemics.

It has been concluded that during the earlier epidemic, mature balsam fir was substantially wiped out over the area, but that seedlings were not affected. Now that they have grown to maturity, they provide a base for a renewed epidemic. Timber surveys in the area, one in 1926 and another in 1948, showed that during this brief period spruce decreased by 12 percent and balsam fir increased by 337 percent in volume.

The general conclusion is that changes in the forest composition and the recurrence of spruce budworm outbreaks are phases in a natural cycle of events associated with the maturing of balsam fir.

Colombia

• Established in 1941, a factory at Buenaventura is producing high quality tanning extract from mangrove bark. After the trees have been felled, the bark is peeled off by axe and transported to the mill site in pieces about 20 × 150 centimeters. Bark thickness varies from 15 to 25 millimeters, and one tree gives about 500 to 1,200 kilograms of bark (green weight). The best bark contains about 16 percent tannin (on weight of green bark).

Finland

• The Central Association of Finnish Woodworking Industries published in 1954 a bulletin entitled *Analysis of Time Study Materials of Some Forest Jobs* by Jaakko Vöry (in Finnish, with an English summary). Systematic work studies in forestry have for a long time been carried out to help establish wage rates for piecework. The factors affecting a forest worker's output are many and continually changing, thus introducing problems which do not occur in other fields of work. Investigations must be confined to measurements of working time, i.e. time studies.

Although research in this field began only relatively recently, it is today being extended in many countries which have an important forest industry. Time study observation series in the forest cannot in general be as precise as industrial work studies, which raises questions as to the validity of the conclusions, and as to the extent to which data obtained by different investigators have generally application. It was with this in mind that the author made time studies in Scandinavian countries on some typical phases of manual forest work. His findings give a fairly clear picture of the possible comparability of the times required for the performance of the various phases, and valuable information on the best way to treat time study material.

France

• It is claimed that wood is still the cheapest fuel to use in France, especially for cooking. The heat value of 1 kilogram of dry wood (4,110 calories) is equivalent to 0.548 kilogram of coal, 0.934 cubic meters of piped gas, 0.349 kilogram of bottled gas, and 0.777 kilowatt of electricity. On this basis, 4 francs (1 cent) worth of wood, at 4,000 francs per ton, will produce as much heat as 7.67 francs (2 cents) worth of coal, 28 francs (8 cents) of gas, 33.60 francs (10 cents) of butane, or 119 francs (36 cents) worth of electricity.

• An important new forest law, which came into effect in December 1954, provides for the grouping of scattered private forests or land destined for afforestation with a view to facilitating proper management, silviculture, protection and planting, and overcoming the defects of fragmented ownership of forest land. Under the law, "forest groups" can be formed whose members — whether individuals or corporate bodies — are exempt from taxation on property which they bring into the group, except in the case of business or industrial concerns for which, however, taxation is fixed at a low rate. Forest owners associations already in being may become "groups". In the case of joint ownership of properties, the owner or owners holding at least two-thirds of the value of the property can terminate any existing agreement if a "forest group" is created in its place.

An earlier law provided for the establishment of "afforestation sectors" of uncultivated land by the Ministry of Agriculture. Under the new law, owners of land included in such a sector can be required to enter into a "forest association" if they do not wish to form a "group". The law also simplifies the procedure whereby the State may compulsorily acquire neglected properties. If such land falls within an "afforestation sector", supervision may be handed over to the local "Commune" provided the latter will join a "forest group".

Germany

• In addition to their normal system of nutrition through photosynthesis, a considerable number of plant species, in particular forest trees, are able to absorb carbohydrates and proteins direct from the humus, i.e. from organic material. This process, called mycotrophy, is carried out with the help of filamenteous fungi living as symbionts on the roots of their host plants. A few plant species depend exclusively on these fungi for nutrition, lacking the requisite organs for autotrophy (i.e. the chloroplasts of the leaves and the hairy roots). The importance of these fungi are discussed in a publication entitled *Die Bedeutung der Fadenpilze als Symbioten der Pflanzen für die Waldkultur* (R. and M. Falck, Sauerländer's Verlag, Frankfurt-am-Main, 1954).

The study of mycorrhiza and mycotrophy has in recent years been given increasing attention, and may have an important influence on modern silviculture, in particular as regards methods of inducing good natural regeneration, increasing growth, and afforesting poor, arid soils such as savannas and steppes. In this latter connection intensive mycorrhiza research is reported from the U.S.S.R.

In the study in question, the authors deal with the various forms and functions of mycotrophy in forest vegetation, based mainly on studies made in Georgia, U.S.A.

Guam

• Military installations and expanded home building require the import of large quantities of lumber. It is likely that such imports will be increased as it becomes necessary to replace thousands of war-time, temporary buildings and to house a rapidly increasing population. All good timber stands on the island have been cut and the areas have largely been taken over by non-timber trees. There is hardly a good stand of *Intsia bijuga* left; and the remaining *Calophylum inophylum*, *Claoxylon marianum*, and *Artocarpus incisus* trees are largely crooked and heavily limbed. There are small areas of good *Tectona grandis* on the island. It is improbable that sufficient amounts of high quality timber will ever be produced on Guam to affect the need for imports.

Indonesia

• The forest area of Kalimantan (Indonesian Borneo) is estimated at 41.5 million hectares. Out of this about 13 million hectares are true primary forest, of which only about 5 million hectares are accessible at the present time. The remaining forest area includes the coastal swamp forests, the little known scrub forests of Central Kalimantan (Kutai) and the secondary forests, partly destroyed by shifting cultivation, with rather poor natural regeneration. In those places where shifting cultivation has been practised too long, making natural tree regeneration impossible, big alang-alang prairies have replaced the forests.

An FAO Technical Assistance Officer writes that the Kalimantan rain forests and those of Equatorial West Africa are very similar in appearance, to the extent that a forester, brought unawares from Gaboon to the *Dipterocarpus* forests of East Kalimantan, would find the same swamps and jungles, the same hilly, uneven ground, the same multitude of timber species of all age classes, the same buttress

roots, bark colors and stem shapes, and only a closer botanical examination would show him that he was not in Gaboon.

The exact area of the various forest types is not yet known but will be assessed by aerial survey within the next few years. Of the several hundred timber species occurring, only about a dozen are exploited at the present time as so-called "commercial timber". They are classed by their durability, the most durable species ranking as first class.

Controlled timber production in 1953 is reported to have been 112,000 cubic meters, all of it produced by manual labor employed by contractors. Unchecked timber production which escapes any control by the Forest Service, is estimated at about 300,000 cubic meters a year, including forest destruction by shifting cultivation.

The bulk of the rich accessible rain forest of 5 million hectares stretches from the east coast to the mountain range of Central Kalimantan, where timber extraction has been going on for a long time on the banks of the Mahakam (Kutai) river and its affluents. Strip timber cruisings along the Segoj and Senjur rivers, two tributaries of the Mahakam river, report total timber volumes per hectare as high as 300 to 400 cubic meters, with 10 to 50 percent commercial timber species. The volume of commercial timber per hectare assessed by 100 percent surveys in 1953 and 1954, and checked by the FAO Technical Assistance officer in the Mahakam river region, varies between 30 cubic meters and 150 cubic meters for timber of 45 cm. d.b.h. and upwards.

The *Agathis* forest area of the Sampit River region in South Kalimantan is estimated at about 25,000 hectares. In contrast to the extraordinary increment of 20 to 25 cubic meters per hectare of the *Agathis* plantations at Mount Slamet, Central Java, the natural coniferous forests of South Kalimantan stand on soft, poor, acid soils of swamp borders and appear to have an increment of one cubic meter per hectare. The purest stands contain up to 20 to 25 percent hardwoods. Exploited since 1949 at the rate of 200 cubic meters a day by a joint government and privately owned enterprise, the cut-over area is covered two or three years after logging with a very thick natural *Agathis* regeneration of 50 to 60 small trees per square meter, which suggests that the management task will be limited to thinning and improvement fellings.

Japan

• A bulletin of the Forest Experiment Station is devoted to an economic study of a mountain village in the Fukushima region. The village, part of whose land is absorbed into a national forest, is divided by two conflicting claims. It was formerly well-known as a horse-breeding center, and even today the remaining horse-breeders are anxious to keep large areas of the national forest for grazing. However, charcoal production from coppice has been steadily increasing owing to improved communications to consumer markets. While in the past limited to local needs, charcoal production now provides the farm population with additional income, as well as employment in the "dead" season. The enquiry has shown that the income per surface unit from land given over to coppice far exceeds that from grazing. Farmers are therefore advised to change from breeding horses to cows, which can be stall-fed with a consequent saving of grazing land, while it is recommended that the policy should be to increase the area under coppice for producing remunerative charcoal.

Jordan

• The first Arbor Day was celebrated in Amman, the capital of the Hashemite Kingdom of Jordan, on 15 January 1949, when the ceremony took place in the yard of El-Husain College under the patronage of the late King Abdullah. The day became a national holiday. The seventh Arbor Day was celebrated on 15 January 1955, on an unprecedented scale throughout the country. The opening ceremony in Amman took place in the grounds of a new hospital. The ceremony started with a Koran reading according to tradition. The Director of Forests gave a speech emphasizing the importance of forests in the nation's life and encouraged the people to plant trees. The first tree was planted by the Minister of Economy in the name of King Hussein and the Government of Jordan. Altogether, 15,000 seedlings of Aleppo pine and cypress were planted in the grounds of the hospital. Seedlings were distributed by the Forest Department to be planted in all centers of celebration throughout the kingdom.

Lebanon

• A recent decree created 39 new posts of *brigadiers* and forest guards, an increase of 45 percent in the effective strength of the Forest Service. At the same time the latter was raised in status from a *Service* to a *Direction*. The staff have since the beginning of the year been issued with military-type uniforms and a distinctive badge of a silver cedar on a green background. These measures are indicative of the Government's intention to preserve and develop the country's forests on a systematic basis.

Mexico

• The Pan-American Highway which traverses Mexico from north to south, from Ciudad Juarez to El Ocotal, passes not only through the largest towns of Mexico but also through undeveloped regions possessing extremely varied natural resources. *Vida silvestre y recursos naturales a lo largo de la carretera panamericana* (edited by Enrique Beltran and published by the Instituto Mexicano de Recursos Naturales Renovables A.C.) describes these regions from ecological and geographical standpoints and enumerates the various kinds of natural resources to be found: plants, forests and national parks, fish, amphibians, reptiles, birds, mammals and wildlife.

The last chapter deals interestingly with the effect of the highway on conservation and the scientific utilization of natural resources. The effects of such a highway on the living conditions of the local populations of the areas through which it passes are too often overlooked. Interest is focussed on engineering problems, tourist needs, and providing the speediest transport links between important centers. But, at many points, the highway can also contribute to the transformation of the local agricultural economy. In forested areas, for example, exploitation is now an economic proposition. But if such changes are not governed by sound planning, there is grave danger that the natural resources thus opened up may be exploited to exhaustion.

Netherlands

• The long-awaited *Bosschap* (Forestry Board) was established by royal decree in 1954. This Board is a public body which has the legal powers to enact decrees and which has control of the State forests, and of all forestry enterprises, irrespective of size or title. There are 14 members of the Board, of whom seven represent "employers" organizations (one for State forests, one for municipal forests, and five for privately owned forests) and seven the recognized "employees" organizations (the three agricultural workers' unions to which forest workers belong).

The Board's regulating powers include the following:

1. the growing of forest crops and the production of forest products;
2. storage and processing of forest products;
3. management of forest estates;
4. standardization of timber commodities;
5. recruitment, dismissal, wages and working conditions of forest employees, other than government personnel;
6. inspection and registration of forestry enterprises.

The Government may only withhold approval of the Board's regulations on the grounds of conflict with the general interest or with the law. Clearly, the Board will greatly influence future forest policy and legislation in the Netherlands.

New Guinea

• A major development in Australian New Guinea has been the establishment of the plywood factory at Bulolo, which commenced operations in January 1954 and is now producing substantial quantities of first class plywood, the bulk of which is being exported to America and Australia.

Large building demands in the Territory have forced up sawn timber production. Annual cut of logs now exceeds 30,000,000 super feet (136,000 cubic meters) but it is still necessary to import small quantities of sawn material. Measures are in hand for the establishment of further sawmilling operations to obviate this.

There has been a definite striving, particularly by operators in the coniferous stands of the Goldfield area, to extract the maximum recovery from their exceptional raw material by seeking out markets for small dimension stock. Substantial quantities of flitches have been exported to Australia for the production of battery separator veneer.

The range of species acceptable to the trade is constantly widening as they come within the logging range of the sawmills. Research work by the Division of Forest Products (C.S.I.R.O.) is constantly assisting this trend.

• In Netherlands New Guinea the two government sawmills at Sorong and in Hollandia, as well as the privately-owned sawmills at Manokwari and Hollandia, produce mainly assortments of standard measurements. North Borneo grading rules are applied as much as possible to round logs, and the Malayan grading rules to sawn-timber. Production of sawn-timber still does not meet local demands.

There have been successful exports of hewn iron-wood baulks (*Intsia bijuga*) to South Africa, as well as consignments of hardwood logs (*Intsia bijuga* and *Pometia pinnata*) to the Netherlands.

Copal (resin of *Agathis labillardieri*) is mainly shipped to the Netherlands.

Approximate trade figures for 1953 are:

Home production of sawn-timber, squares and logs	9,100 cubic meters
Import of sawn-timber	2,000 cubic meters
Export of squares and logs	980 cubic meters
Export of copal .	564 tons

New Zealand

• In the South Island, the forests of podocarps and other conifers, most characteristic of which is the rimu (*Dacrydium cupressinum*), do not regenerate naturally except with great difficulty and under very special conditions. They are being replaced either by scrub or by species of *Nothofagus*.

"Forest and Climate in the South Island of New Zealand" by J. T. Holloway (reprinted from the *Transactions of the Royal Society of New Zealand*, Vol. 82, Part 2, September 1954) attempts to explain the seeming state of disequilibrium or maladjustment to present climatic conditions of the natural forests. The author produces the hypothesis that the whole of the island's vegetation is at present in a state of dynamic evolution set in motion by climatic changes which took place about the 13th century A.D. These changes consisted in a perceptible cooling of the climate, which lowered the limit of occurrence of *Nothofagus*, whose habitat was previously in the upper areas of the western mountains. This was accompanied by a decrease in rainfall, favoring the extension of tussock grasslands.

The South Island of New Zealand is particularly suited to the study of climatic changes and their biological consequences, due to its geographical situation; the variety of regional climates; the absence, until the advent of the first white settlers, of a human agency of importance affecting the forests as a whole, and the absence of mammals; the longevity of most podocarp species; and the peculiar mode of propagation of *Nothofagus* (seed carried by water courses), which makes it easy to trace its migration pattern.

• Further attention has been paid to the grading of *Pinus radiata*. The two grades for framing have been re-named No. 1 framing and No. 2 framing, and are now widely accepted throughout the country, provided that the durability factor is taken care of by preservation, where required. For some building components subject to bending stresses, the depth has been increased slightly as compared with that employed previously with rimu. A "factory" grade is now included among standard grades and is very popular in both the domestic and Australian markets for cutting purposes (furniture, joinery and miscellaneous wooden-ware). The quality of the timber cut from the clear lengths is now recognized as very good from points of view of machining and finishing. Intermediate between "dressing" grade and "boxing" grade is a new grade called "merchantable" suitable for rough work as full length pieces or for cutting purposes of a cheaper nature than those for which "factory" grade is used.

To meet current deficiencies in supply of native softwood timbers for finishing purposes (a use for which the exotic softwoods have only a limited application at present because of the inherent defects), increasing use is being made of native hardwoods, especially the beech timbers and tawa. Tentative grades drawn up for the three most important beech species generally follow the pattern of rules laid down for rimu in the National Grading Rules, New Zealand Standard Specification No. 169. Already the grades in use for tawa has led to its being widely accepted for flooring and interior woodwork. It is anticipated that the exotic softwoods will be of sufficiently good grade to meet many of the needs for finishing timbers.

The National Grading Rules for building timbers were formulated at a time when use, full length, of clear boards was considered the logical procedure in building for all finishing purposes. There is a need for revision of this approach to make more use, especially in flooring, of shorter clear lengths available from lower grades. These could logically be considered for end-matched flooring, and eventually the native timbers of high quality would more logically be used for a finish flooring over an exotic pine sub-floor. This is the general trend of thought today.

Nicaragua

• An important area of coniferous forest is situated in the northwestern mountainous region of the country, at elevations over 600 meters above sea level. The total area is supposed to be about 170,000 hectares, mainly consisting of *Pinus oocarpa*, and the forests show much resemblance to adjacent areas in Honduras. The average volume per hectare does not exceed 50-100 cubic meters and the forest is much subject to fire and erosion.

The rest of the pine forest area is almost completely concentrated in the northeastern part of the Atlantic coastal area, roughly between the Río Grande and the Río Coco. Available data indicate an area of 670,000 hectares but from an air reconnaissance flight, a FAO Technical Assistsance officer assumes the actual area to be bigger. The pines occur mostly in pockets of varying size. Close to the Río Coco, the pine forest appears to extend over considerable areas and to be of good quality. On the whole, however, forests, consisting of *Pinus caribea*, are in poor shape, not exceeding 15 cubic meters per hectare as an average volume. The whole area is burned over every year, and in many places even three times a year. Natural regeneration, although very promising in many parts, cannot get established, and the trees left over after exploitation or which survive after many years of burning, are of poor shape, showing big holes from fire damage and attacks from white ants (*comejenes*).

There are two extensive broadleaved forest areas, mostly evergreens with some areas of deciduous species, the first area being mainly situated on the northwestern hill slopes and adjacent plain regions towards the Atlantic Ocean; the other on the opposite mountain slopes and some plain areas towards the Pacific Ocean. A big part of the existing forest area of the country is still quite inaccessible owing to lack of roads, but this could quite easily be rectified. A road connection between the Pacific

and Atlantic coast areas would open a considerable part of the broad-leaved forests, while the pine forest areas of the Atlantic coastal area part do not offer any particular road-construction difficulties. A road system of about 400 kilometers has already been constructed here by a commercial timber corporation and there is a very good road between Puerto Cabezas and the Río Coco (160 km.). This company spends about U.S. $2.85 on road building for every 1,000 board feet of sawn lumber produced.

Road construction in the mountainous northern part of the country is much more expensive. Nevertheless existing sawmill companies have constructed a good system of roads, transporting the lumber to Managua sometimes over distances of more than 200 kilometers.

Peru

• A recent issue of the *Boletin de la Facultad de Ingenieria Forestal*, Universidad de los Andes, Merida, Venezuela, is devoted to a report on the forest resources of Peru. It has much to say on the introduction and cultivation of *Eucalyptus globulus* in the Sierras which has been a complete success. The ease with which it can be grown, its hardiness and the rapidity with which it puts on volume, have made it possible to alleviate the scarcity of firewood and timber in the inter-Andean valleys which have long been almost denuded of trees. The eucalypt has provided not only local supplies but also furnishes a readily accessible source of timber for the mining industry. The high prices offered by the mines have encouraged private enterprise to plant industrial forests without government loans.

Fears that good agricultural land might be taken for the plantations have proved unfounded, and the eucalypts are generally planted on marginal lands where, on account of the high altitude, coldness of the climate or poor quality of the soil, they are economically more profitable and give better yields than agricultural crops. Except as windbreaks and boundary lines, they do not seem to have been planted on areas suited to intensive agriculture.

Puerto Rico

• The Tropical Forest Research Center is just completing the establishment of a laboratory for making machining and other simple physical tests on local woods. The present research program contemplates the testing of 50 species during this year. The tests include specific gravity, drying time and characteristics, planing, sanding, boring, mortising, turning, bending, resistance to splitting, nail holding, gluing, and finishing. In addition, local woods are to be tested by fabricating a number of items from them, such as containers.

Ryukyu Islands

• The silvicultural practices of greatest present significance are those adhered to in the management of private and community forests. In the main, these are empirical methods handed down from generation to generation, or adaptations of the methods of long-departed leaders. Inhabitants of individual islands, or of island groups, revere their own sages and call them to mind to provide inspiration during Arbor Week and other community activities in forestry. Among them, the man generally acknowledged as having done most is Saion, an early eighteenth-century prime minister, exceptional both for creating a lasting foundation of policy and practice and for preserving its essential features in writing.

In assessing the forest situation in 1738, he wrote:

> "The reason why the wooded mountains have lost their prosperity and appear as they are now is due to lack of knowledge of the mountain conditions, as a result of which the closely embraced and protected entrances are opened deliberately by burning and felling trees, thereby allowing the mountain atmosphere to escape until the trees of the interior are damaged; this is one of the reasons. Owing to lack of knowledge of methods to foster and develop the wooded mountains on the part of those entering the mountains, trees are left uncared for and this provides the background for the decline of these mountains; this is another reason. The reckless overrating of farming induced the people to burn forest; this is the third reason. As it is impossible for this country not to build ships and not to build and repair the royal palaces with large timber, in spite of the fact that the wooded mountains are getting worse, it will therefore be necessary to order large timber from outside the country. If this is the case, we must pay the price for the timber and its transportation charge, and this in turn will cause us to order the farmers to pay money and rice to meet the purpose. But by so doing, everyone in the country will surely be financially distressed. As the situation stands like this, the wooded mountains must be preserved with care and energy... ."

Sudan

• A report of the Forests Department gives a too familiar picture of the results of the high demand for wood fuel around Khartoum, the capital of Sudan. Railed firewood coming from southern districts was inadequate and supplies were augmented by the cutting of dead scrub from the regions lying northeast of Khartoum and northwest of Omdurman. Many permits were granted to owners of private land on the Blue Nile and the main Nile to clear their land of trees for sale in the local markets. Local Arabs were engaged in bringing dead scrub into the towns from as far away as 70 miles (113 km.), in some cases bringing the wood to collecting centers on the main Nile banks whence it was transported to Omdurman by boat. As a consequence of this heavy demand for firewood, all forestry staff around the towns were kept busy preventing the illicit cutting of green wood.

The report also gives another side of the picture. Although, it states, the usual opposition to the reservation of land for central forest reserves was encountered, local councils proved more amenable in the matter of provincial reserves. Fuel and pole plots established in 1948 have been such a success that the local inhabitants are eager to buy and have asked for plantations to be extended. This is the first time in the history of the particular Forest Division that a request has been made for the Forests Department to take over and plant up land.

Switzerland

• An article in the journal of the Swiss builders and wood workers suggests that only the oldest among its readers can still remember the days when streets and bridges — even in the big towns — were paved with wood. Nevertheless wooden paving is gradually returning to the market and making a place for itself in a specialized branch, as flooring in places where it cannot be competed with by other materials — industrial buildings such as workshops, machine shops, rolling mills, iron-works, automobile factories, railway workshops, warehouses, hangars, and also in stables, sports buildings and gymnasiums.

The properties that have made such a come-back possible are that wood paving is elastic, warm under foot, deadens sound and vibration, is light in weight — and can therefore also be used for upper floors — and maintains a dull non-slip surface for an unlimited period of time. After working for many hours on wood paving floors, workers do not evince signs of tiredness in the same way as when they have to stand on concrete or stone.

Wooden paving blocks are made from home-grown timber, usually cut to a measurement of 8 centimeters across and 6 to 10 centimeters deep. They are impregnated in the same way as railway sleepers and last practically indefinitely. As they are cut from "waste" that cannot usually be used for any other purpose, it is also very much in the interest of forestry that wood paving should regain a position in the market.

Turkey

• An FAO Technical Assistance officer reports that a new headquarters in Ankara is being prepared for the Forest Research Institute of Turkey. It is hoped that it will be ready for occupation in 1955.

During the past year, experiments the first of their kind in Turkey have been made on improving open range land and the results are very encouraging. Not only has the production of milk per animal increased as a result of the improved range forage but, even with fewer animals, the production of milk per hectare is higher. It is becoming more widely recognized that forest grazing, although not always compatible with forestry, has many possibilities if properly managed, and that in many instances such dual use of the forest is an advantage.

Union of Soviet Socialist Republics

• A paper presented at the Fourth World Forestry Congress contained some interesting information about experiments in sand-dune afforestation in Latvia. Afforestation of the 7,900 hectares of moving dunes, started in 1830, is now virtually completed, but certain problems still remain to be solved.

With the exception of grasses such as *Elymus arenarius* and *Ammophila arenaria* or shrubs such as *Betula verrucosa*, *Alnus glutinosa* and in particular *Salix purpurea*, the only forest species that appear capable of growing in ground which is so low in calcareous and humus content are *Pinus silvestris*, *P. banksiana* and, of less interest, *P. montana*. It would seem that the potassium, phosphorous and moisture content of the soil is sufficient for the growing of pines, but they spread their root systems over a very wide area to obtain sufficient moisture. For some reason the roots do not penetrate deep into the ground to levels where there is more adequate moisture. The problem of maintaining an adequate moisture supply near the surface has been overcome by placing a layer of turf (5 centimeters thick) or of branches (10 centimeters thick) at a depth of 40 centimeters in the furrows prepared for planting out young trees.

While planting with broadleaved species alone did not appear feasible without soil preparation, good results were obtained by mixing conifers with broadleaved species, in particular with *Alnus glutinosa* and *A. incana* which not only gave a high percentage of successful plantings but also improved the rate of growth for the first 10 or 16 years. The most desirable spacing of trees to produce speedily a good canopy has not yet been determined.

United Kingdom

• For many months, the Timber Trade Federation had been urging the Government to grant facilities for the reopening of trade in hardwoods from the dollar area which, over a long period, used to be restricted to specialties unobtainable from other sources. The Board of Trade has now established a quota at the annual rate of £.3 million f.o.b. ($8.4 million) for the import of general purpose hardwoods from the dollar countries. The quota will be allocated in two half-yearly instalments to hardwood-using firms and hardwood importers, individual shares being determined on the basis of usage and imports in a specified period.

The sum will go some way towards reviving what was in pre-war days a flourishing branch of the hardwood trade. Uniformly graded and well-prepared hardwoods from the United States are firm favorites among industrial users, especially furniture manufacturers. Canadian timbers, notably birch and maple, also rank among species of high utility value. The London *Times* thinks that freer importation from the dollar area as a whole will contribute to the stabilization of world hardwood prices.

• *Experiments in Tree Planting on Peat* is the subject of Forestry Commission Bulletin No. 22.

There is no greater potential field for the expansion of forestry in Great Britain than the peat-covered hills and moorlands of the north and west. Private landowners made various attempts to establish plantations of conifers on these lands before the first world war which were largely unsuccessful but, with the setting-up of the Forestry Commission after that war, renewed attention was given to this problem.

This bulletin evaluates results of experiments to date, including the classification of the peat lands, the vegetation type supported by the peat and the exposure class — that is, slope, aspect and relative elevation of the ground. The success or failure of both experimental and large-scale plantings are found to conform to these basic classifications, modified of course by method of site preparation.

Early experiments showed that special steps in ground preparation were essential. Plowing and turfing, both for drainage and to prepare for setting plants with their roots spread below the turf, with furrows at about five-foot (1.5 m.) intervals are the accepted practice. Although some differences in ground preparation have been found advisable on the different vegetation and turf types, it has not yet been determined how much additional turfing and drainage is economically desirable.

The species used most extensively have been Scots pine, Japanese larch, and Norway and Sitka spruces, while contorta pine and hybrid larch have been used less extensively. For each of the main species, reasonably sound conclusions can be drawn as to adaptability to the different types and methods of ground preparation. Experiments in mixed plantings have been made but it is not yet possible to draw firm conclusions in this field. On poorer peats, manuring with phosphate is now established practice.

The general conclusion is optimistic, for successful establishment of plantations is now being obtained far beyond earlier experience. It is a humbling thought, however, that after 30 years of careful experiments, another 20 years of observation of trial plantations is considered necessary before safe conclusions can be drawn as a guide to general practice.

United States of America

• On 1 February 1955, the Forest Service of the Federal Department of Agriculture initiated the celebration of its 50th or Golden Anniversary Year. It is planned to use this occasion as an opportunity to re-emphasize to the American people:

1. the consequences of their determined action to set up and maintain the Forest Service and the National Forests;
2. the progress made in forestry both on public and private lands, and by various agencies during the half century;
3. the many essential goods and services obtainable from managed forest lands and the dependence of the people and economy on them;
4. the greater progress needed in the future and the various steps necessary to accomplish the goal envisaged.

It is expected that forest officers everywhere will take part in these endeavors, together with all others directly concerned with forestry and with citizens whose loyal and understanding support has carried the Forest Service through many times of adversity.

One event in the celebration of the Anniversary was a formal dinner given on 4 February in Washington, D.C. by the Society of American Foresters and the American Forestry Association, attended by 500 friends of the United States Forest Service. An honored guest at the dinner was Mrs. Gifford Pinchot, widow of the first chief of the Forest Service.

• The American Forestry Association, whose membership includes many leading figures in forestry and the timber industries, last year submitted to ballot an important program for American forestry which was approved by 93 percent of the members who voted.

The program is a real statement of forest policy which the Association pledges to support. While reaffirming its attachment to the system of

federal and state forests, the program recommends the establishment of a joint committee, consisting of members of various Senate and House committees, whose objectives would be "to consider a desirable pattern for ownership of federal, state and private forest, range and other conservation lands", and to formulate policies for achieving this pattern. The Committee would receive reports on this subject drawn up by similar committees appointed by the governor of each state. The program recommends:

> "development of state policies methods or laws by the people of each state to avoid unnecessary destruction for growing stock and young growth and to assure practices that will maintain continuous production on forest lands."

A small number of members were opposed to any type of public control, but others believed that some form of federal regulation is required.

Some members also voted against an article of the program recommending that "permits to graze livestock on public lands be considered a privilege and not a legal right," and against various sections relating to the public acquisition of forests in connection with protection and management of watershed areas, recreational forests and technical assistance to forest owners.

• A report issued by the Engineering Experiment Station of the Georgia Institute of Technology discusses the subject of bamboos as an industrial raw material taking into account their characteristics, properties, suitable localities for cultivation, their possible uses, and economics. A major difficulty still exists in the poorly organized nomenclature which, despite much work, is still far from satisfactory.

Uses for bamboo in the United States, though by no means as extensive as in Asia, are nevertheless numerous. The report concludes that full exploitation is conditioned upon:

1. setting up plantations of different species large enough to determine best and most economical methods of production;
2. large-scale plantings of species suitable for pulp to provide supplies for experiments;
3. further study of the physical properties of different species to determine curing conditions and processes for each end use.

• Pentachlorophenol, copper naphthenate, zinc naphthenate, and a number of less common wood-preserving chemicals often require dilution with some type of petroleum solvent before they are used. Such chemicals are prepared in concentrated form to avoid the necessity of shipping the diluent, which can be purchased locally.

Diluents recommended in the past have included fuel oil, kerosene, Stoddard's solvent, and used crankcase oil — the latter, because test fence posts treated with toxic crankcase oil solutions have often shown better results than posts that were treated with solutions prepared from lighter oils. However, tests by the Illinois Agricultural Experiment Station in which crankcase oil was boiled to remove any water and low-boiling fractions and strained to remove gummy substances and particles of soil and metal, have proved it unsatisfactory as a diluent because of possible sludging and precipitation of toxicant (particularly with pentachlorophenol).

Veterinarians have also discovered that hyperkeratoris (X-disease) of cattle is caused by chlorinated naphthalenes, compounds that may be present in crankcase oil. Hence, in view of these factors, crankcase oil appears undesirable as a diluent for wood-preserving chemicals, particularly when wood is to be installed on the farm.

In a study *The Effect of Synthetic Resin Adhesives on the Strength and Physical Properties of Wood Veneer Laminates* (Bulletin No. 60, Yale University School of Forestry, New Haven, Connecticut), designed to determine the extent to which the properties of wood veneer laminates are influenced by synthetic resin glue lines, the tensile and flexural strength and certain elastic properties were investigated for hot-pressed plywood and laminated wood constructed of yellow poplar (*Liriodendron tulipifera* L.) veneer. Six commercially important types of synthetic resin adhesive were used, and veneer thickness was varied from 1/10 to 1/60 inch (0.3-0.04 cm.) with sufficient sheets being used to form panels approximately 3/10 inch (0.75 cm.) in over-all thickness.

The study indicated that synthetic resin adhesives differ basically from impregnating resins in their influence on the wood component. Of the properties investigated fiber stress at proportional limit in static bending was least influenced, whereas modulus of rupture and work to maximum load in static bending and ultimate tensile strength were improved to the greatest extent. Properties, however, were not similarly influenced by all adhesives nor were all influenced proportionately by any one adhesive.

The test results suggest that extensive cell-wall impregnation does not occur and that the influence of the laminating process may be largely attributed to:

1. veneer compression in the vicinity of the glue line;
2. deposits of polymerized adhesive in the porous structure of the veneer;
3. deposits of polymerized adhesive in the pits and torn areas of the cell wall thereby improving resistance to longitudinal shear.

It is indicated that the basic change in properties occurs largely in the area of the glue line.

Selected Reviews

WOODLAND MANAGEMENT. W. E. Hiley. pp. 463. Faber and Faber Ltd. London. 1954. 63 shillings.

Starting from the premise that forestry has too long been regarded in the United Kingdom as an unremunerative operation, or at least of little interest to capital investors, the author sets out to show that, for the owner who makes the necessary investments and ensures proper management of his woodlands, as he would do for any other sound business, forestry can be made to pay. In order to achieve this, all phases of forest management need to be critically examined, which the author does under the following headings:

1. the organization of a woodlands department, that is, supervision and control, management plans, contract work, labor and wages, equipment, extraction;
2. the production, felling and conversion of woodland products including problems relating to the measurement and sale of timber;
3. woodland maintenance, including natural regeneration, establishing plantations, choice of species and of silvicultural system;
4. woodland administration, including regulation of yield, accounting and costing.

That forestry can be a paying concern is based on the assumption that the present remunerative prices for timber will not fall again to impossible levels. The author asserts that this assumption is justified.

> "The days of cheap timber, mined from the virgin forests of the world, may be over, and foresters may look forward with some confidence to obtaining remunerative prices for the timber which they grow, but the present prices are higher than is necessary to encourage a healthy forest industry, and boom conditions nearly always lead to a recession in trade."

The chapter on the profitableness of forestry is particularly interesting. Based on the latest Forestry Commission yield tables for Scots pine, European larch, Japanese larch, Norway spruce, Sitka spruce and Douglas fir, the rates of interest which may be expected appear to vary between slightly over 1 percent and slightly over 7 percent, depending on the species, length of rotation and site quality.

The chapters dealing with legal restrictions on woodland management, state assistance to forest owners and taxation of woodlands will also be read with much interest, and the very great advantages which a landowner wishing to plant woodlands can enjoy in the United Kingdom will be particularly noted. The final chapter on small estates will well bear study by all who are concerned with the problems involved in this class of property, both on the national and international level. Mr. Hiley examines the various means, including co-operative associations, which the owner of an area of woodland that cannot by itself constitute an independent economic unit, may use to secure for his property the benefit of sound management.

In brief, besides the undoubted interest of this book for the private forest owner in the United Kingdom, many of the problems discussed and the solutions propounded are of common interest to foresters all over the world. Moreover, the book is written in clear and precise language which makes it particularly readable and persuasive.

PRINCIPLES OF GENERAL ECOLOGY. A. M. Woodbury. pp. 503. The Blakiston Co. Inc., Toronto and Country Life Press, Garden City, New York. 1954. U.S.$6.00.

From the vast literature dealing with ecology the author has attempted to combine in a single volume the various findings to date on the subject. On the basis of the several accepted systems of classification, the author has divided the subject into:

1. *Physical environment*
   - (*a*) soil, water, air and its constituents;
   - (*b*) radiant energy;
   - (*c*) gravity and periodicities;
   - (*d*) climate;
   - (*e*) adaptation to the physical environment.
2. *Biotic relations*
   - (*a*) biotic communities and their development;
   - (*b*) community analysis and conditions of existence — energy, space, shelter, protection;
   - (*c*) food relations;
   - (*d*) reproduction and species persistence;
   - (*e*) population problems;
   - (*f*) evolution;
   - (*g*) biotic rhythms and migrations;
   - (*h*) historical distribution;
   - (*j*) geographic distribution;
   - (*k*) consortism;
   - (*l*) social relations;
   - (*m*) societies;
   - (*n*) ecology and human affairs.

Specialists in the field may object to the author's choice of examples and to the inclusion or omission of items in the bibliography. However, the book opens the way to a broad understanding of the complex of environment and its living creatures, as to why particular landscapes and communities exist, and to the effects of major interference with nature.

FORSTWIRTSCHAFTSPOLITIK. (Forest Policy). V. Fieterich. pp. 398. Paul Parey. Hamburg and Berlin. 1953. DM. 38.60.

A well-founded, national forest policy depends upon a sound understanding of the relationship between forests and people, and between forest economy and the national economy; it implies too, a sustained effort to balance the often conflicting claims on the forest by the various sectors of the economy.

The author of this book, until recently head of the Institute of Forest Policy and Economics at Munich University, abandons the traditional attitude to the forest as being a source of raw material, for a broader one — its role in man's development. He analyses the various complex functions of the forest and their influence on people in such fields as production, labor, income, property, protection, recreation, human welfare and ethics, and succeeds in presenting the forest in its true perspective to the life of men and nations and not merely as a source of commercial products.

DAS NATURLICHE WALDBILD EUROPAS (The Natural Forest Cover of Europe). K. Rubner and F. Reinhold. pp. 304. Paul Parey. Hamburg and Berlin. 1953. DM. 13.00.

Decades of experience in western Europe have shown that growing forests according to principles borrowed from agriculture, that is the production of generation after generation of uniform crops, entails grave dangers to the maintenance of soil fertility and growth rate. There are numerous examples where the raising of pure conifer plantations for centuries without consideration of the needs of the land has resulted in severe soil degradation and reduction of its productive capacity. The realization of this trend on many forest sites in western Europe has swung opinion against any kind of unnatural monoculture unless the effects on the soil are compensated by appropriate measures such as the use of soil fertilizers. The modern view is that silviculture must be based on a thorough knowledge of the original forest cover types of

each particular site or region, and must maintain any new forest cover in equilibrium with the site conditions.

The authors have undertaken the task of bringing together all available information on the natural forest cover of Europe and have followed the Braun-Blanquet classification system. The publication is divided into three parts: the first part classifies the climate and soil types of Europe, based on the duration of the tree growth period, i.e., the number of days per year with a mean temperature of above 10°C. The second part describes the natural forest regions of Europe; and the third, and shortest part, attempts to establish a basis for a consistent European silviculture.

PUBLIC POLICY TOWARD PRIVATE FOREST LAND IN SWEDEN, NORWAY AND FINLAND. R. E. Marsh. pp. 80. The Charles Lathrop Pack Forestry Foundation. Washington 1954. $1.00.

The present study undertaken at the request of the United States Forest Service is concerned with forest policy in regard to private forests and, more particularly, to small woodlands or "farm forests". Its principal aim was to discover whether the methods used in Sweden, Norway and Finland carried any lessons for conditions in the United States.

In general, the policies applied to farm forests are in many ways similar in all three countries as their economic and social conditions are also similar: they are well-wooded, sparsely populated, with highly developed timber industries, where timber is of prime importance in the export trade. Private forests, and particularly farm forests, are highly developed. The wood lot occupies a preponderant place in the economy of every farm, and many farms would not be able to survive without it. It is not surprising that in these circumstances a profound feeling for the forest has taken root among the population, and that owners recognize and willingly accept State supervision of their operations which is accompanied, however, by effective assistance, especially from co-operative associations.

There are, however, some important differences, mainly of principle, due partly to the varied social development of the three countries and partly to the different effects of the last world war on each of them.

Much instructive information is given in the book on the legal definition of what constitutes "forest", on the laws bearing on forest clearing, the development of community forests, co-operatives and associations of private forest owners and their relationships with the agencies responsible for carrying out the forest law relating to private forests. Despite the progress made in the three countries, officials of the forest services who were consulted by the author, stated that there was still much more to be done. Forestry practices on a large percentage of farm forests, mainly small woodlots, are still considered to be poor, and a substantial increase in growth and yield is thought possible if proper silviculture and management can be applied.

URWALDPRAXIS (Virgin Forests). J. Fröhlich. pp. 200. Neumann Verlag. Radebeul and Berlin. 1954. DM. 12.50.

European foresters attempting to establish healthy forest crops are faced with problems arising from the fact that, in the course of the past 200 years, many of Europe's forests have been converted into uniform stands of species often unsuited to the site or produced from poor seed.

The best source of information on the biology of the individual tree species comprising these stands is of course the rapidly vanishing virgin forest. To provide such information, the author has published his experiences and observations acquired in 40 years' practical work in the virgin forests of southeastern Europe and the Near East.

He first describes the stand composition and the main species found, showing that, contrary perhaps to general belief, the trees are distinctly heterogeneous in age and diameter, and the species are sometimes mixed, sometimes uniform, depending on the site conditions. Natural regeneration of pure spruce forests has usually been found by experience to be practically impossible, but natural mixed spruce stands, particularly those containing a proportion of beech or other broadleaved species, lent themselves more readily to natural reproduction. The mixed virgin forests also appear to have been comparatively resistant to serious insect attacks.

METHODS OF SURVEYING AND MEASURING VEGETATION. D. Brown. pp. 223. Commonwealth Agricultural Bureaux Bulletin No. 42. Commonwealth Bureau of Pastures and Field Crops. 1953. 35 shillings.

In many parts of the world, forest lands produce forage and are grazed. In some countries, research and surveys of the forage available for grazing have led to improved management and improvement of forest conditions, whereas in others grazing is a major problem to be solved before forestry can be successfully practised. Since total exclusion of grazing from the forest may not always be the best solution, foresters may be confronted with the need to take an inventory of grazing resources and to sample the herbaceous vegetation within the forest as a first step toward improved management.

Since the wide variety of methods for appraising grassland vegetation makes it difficult for novice and expert alike to appreciate the advantages and disadvantages of each, this bulletin provides a valuable review of world literature on the subject, analyzing techniques on the basis of the experience in the field.

After an introductory discussion of the broad vegetation types and the theory of sampling vegetation, the bulletin groups the various methods of measuring forage productivity and utilization on the basis of the job to be done. There is a valuable glossary of terms and units of measurement used.

THE FLOOD CONTROL CONTROVERSY (Big Dams, Little Dams and Land Management). L. B. Leopold and T. Maddock Jr. pp. 278. Ronald Press Company. New York. 1954. U.S. $ 5.00.

This book, sponsored by the Conservation Foundation and written by two authorities on the subject, is not specially written for foresters but is designed to present the facts on methods of flood control used in the United States.

Two schools of thought have developed since work in flood control began 25 to 30 years ago: one held by the Corps of Engineers that downstream structures such as reservoirs, levee systems and related structures in major river valleys are the more important, and the other held by the Department of Agriculture that land management and small upstream structures are most important.

The authors point out that although existing legislation does not define adequately the responsibilities of each group, much of the controversy stems from an incomplete understanding of the factors involved and the true place of each control method. Land management and vegetative cover are not sufficient in themselves to prevent or control floods, but they may reduce flood damage in three ways by:

1. promoting an increase in the volume of water retained in the soil;
2. increasing the rate of infiltration of water into the soil;
3. reducing erosion losses.

As watersheds increase in size and as the factors causing floods accumulate and become greater, however, land management and vegetative cover have progressively less effect in flood control. It was realization of this fact that spurred the Department of Agriculture to construct small dams in the upper reaches of watersheds. It is these "little dams" versus the "big dams" which cause continuing controversy, abetted by the fact that watershed management for the conservation of soil and the improvement of productivity has become intermixed with the concept of flood control proper.

CONSERVATION LAW AND ADMINISTRATION. W. F. Schultz Jr. pp. 607. Ronald Press Company. New York. U.S. $ 10.00.

This book, although entirely devoted to the State of Pennsylvania, is of value to all who are interested in legislation on conservation of natural resources. The complexity of the situation, which is still further increased by the federal character of the United States of America, is due to the fact that, "in Pennsylvania are met practically all factors that have a major effect upon the use of natural resources."

Although efforts have been made to solve existing problems, these are inadequate for two reasons:

1. the excessive number and complexity of the State agencies charged with the conservation of natural resouces, often with overlapping functions;
2. the lack of public education for conservation.

Chapters are devoted to wildlife conservation, game and fishing laws, water conservation and management, forestry, soil conservation and recreation with an analysis of the policies adopted and the relevant legislation implementing them and the administrative agencies responsible for seeing that they are observed.

The study, an outstanding contribution to the history of conservation, ends with a proposed model act to improve conservation administration operated by a special Department of Conservation.

DAS HOLZ (Timber). H. Knuchel. pp. 472. H. R. Sauerländer and Co., Aarau (Switzerland) and Frankfurt a/M (Germany). 1954. Sw. fr. 27.0 or DM. 27.0.

Research on wood and its properties and uses has made great advances in recent decades, and the present book sets out to inform the wood-processing industries and the trade of the state of present knowledge.

It gives, in condensed form, an outline of:

1. wood growth and morphology, wood properties (physical, mechanical, technical, commercial), wood irregularities and defects;
2. wood utilization (wood working, engineering, wood chemistry, etc.);
3. directory of the commercially important wood species of the world.

This third and longest section contains as complete as possible a synopsis of the timbers of the world with concise descriptions of their essential properties.

The author, who recently retired from the Chair of Wood Technology at the Swiss Federal Institute of Technology, Zurich, which he held for thirty years, has concentrated in this publication the knowledge and experience of a lifetime. Excellent alike in the completeness of its contents and the simplicity of its style, it is valuable for all concerned with wood and its utilization.

Another publication by the same author, *Planning and Control in the Managed Forest* (reviewed in *Unasylva*, Vol. V, No. 2, p. 94) has been issued in an English version, prepared by M. L. Anderson, and published by Oliver and Boyd, Edinburgh, price 35 shillings.

SOIL EROSION SURVEY OF LATIN AMERICA. Joint publication of the Conservation Foundation, New York, and FAO. Reprint from the July, September and November 1954 issues of the *Journal of Soil and Water Conservation*. Available on request from the Conservation Foundation, 30 East 40th Street, New York 16, N.Y., U.S.A.

This publication is the result of a joint survey by the Conservation Foundation and FAO which had as its aim to review the causes and possible remedies of soil erosion in Latin America, with a view to stimulating individual nations of this vast region to study in greater detail the facts and implications of erosion within their borders. The survey was conducted by three prominent soil experts who prepared maps for Central America and the West Indies and for the northern and southern parts of South America, classify ing the various degrees of soil erosion.

Although the distribution of severe erosion areas naturally depends on the physical conditions and essentially on land relief, it is closely related to changing human agency. There are indications that, in many places, accelerated soil erosion began long before settlement of the land by the white man, and was caused by farming, particularly the growing of corn (maize), and was later aggravated by the introduction of livestock and failure to manage grazing lands properly.

The same causes are to be found in the mountainous parts of the north of South America, with additional factors such as wind erosion and uncontrolled use of fire on range lands, in particular on the *altiplano* of Bolivia and the *pampas* of Argentina. In Brazil, two further causes of accelerated erosion have affected a wide area, coffee and cotton growing; the former, since it is often grown under a system of shifting cultivation, and the latter, because it has a tendency to provoke erosion on soils that are liable to it.

In Latin America as a whole, no efforts to arrest soil erosion equal to the magnitude of the problem have yet been made, although valuable individual projects may be cited, especially in Venezuela and Mexico, and in the State of São Paulo, Brazil, which established the first soil conservation organization in South America in 1939.

TIPOGRAFICA CASTALDI - ROMA - 1955

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